EXHIBIT 1

HOAU-YAN WANG, Ph.D.

E-MAIL ADDRESS: [redacted]

ADDRESS: C[redacted]

PHONE: [redacted][Office] [redacted] [Lab] [redacted] [Cell]

EDUCATION:

Medical College of PA, Philadelphia, PA	1988 - Pharmacology, Ph.D.
St. John's University, New York, NY	1985 - Pharmacology, M.S.
China Medical College, Taiwan	1981 - Pharmacy, B.S.

EMPLOYMENT:

2019-present	CUNY School of Medicine at City College, New York, NY Medical Professor, Molecular, Cellular & Biomedical Sciences
2001-2019	CUNY Medical School at City College, New York, NY Associate Medical Professor, Physiology, Pharmacology & Neuroscience **(Tenured, May 2006)**
2001	R.W. Johnson Pharmaceutical Research Institute, Spring House, PA Principal Scientist, CNS Research
1998 - 2000	R.W. Johnson Pharmaceutical Research Institute, Spring House, PA Senior Scientist, CNS Research
1998 - 2001	MCP-Hahnemann University School of Medicine, Philadelphia, PA Adjunct Assistant Professor, Pharmacology & Physiology
1994 - 1997	Allegheny University of the Health Sciences/MCP, Philadelphia, PA Assistant Professor, Pharmacology & Psychiatry
1992 - 1994	Medical College of PA (MCP), Philadelphia, PA Assistant Professor, Psychiatry
1990 - 1992	Medical College of PA (MCP), Philadelphia, PA Instructor, Psychiatry

CURRENT RESEARCH INTERESTS:

- Age-dependent alterations in neuronal function and the underlying mechanisms.
- Pathogenic mechanisms and therapeutic targets for neurodegeneration in Alzheimer's disease

- Pathogenic mechanisms and therapeutic targets for neuropsychiatric disorders with particular emphasis on bipolar affective disorder and schizophrenia.
- Discovery of novel therapeutic agents and diagnostic biomarkers for neurodegenerative and psychiatric disorders as well as traumatic brain injury.
- Molecular pharmacology, target identification and therapeutic mechanism of psychoactive drugs.

LABORATORY TECHNIQUES AND RESEARCH EXPERTISE:

1. Protein biochemistry, physiology and pharmacology of ionotropic and metabotropic receptors as well as trophic factor receptors.

- Receptor/G protein interactions including GTP binding, calcium signaling, identification and characterization of signal transduction pathways, second messenger (Ca^{2+}, cAMP, cGMP & phosphoinositide) measurement, Lipid acylation, Toxin-activated ADP-ribosylation, lipid peroxidation & reactive oxygen species assessment.
- Protein purification and characterization, immunoprecipitation, 1-D/2-D gel electrophoresis, Western blotting, protein phosphorylation/dephosphorylation, protein kinase and enzymatic activity assay, antibody purification & characterization.
- Receptor binding assay, RIA, EIA, high throughput screening, receptor autoradiography.

2. Molecular and Cellular biology

- General molecular biology techniques-Northern and Southern blotting, cDNA library screening.
- General recombinant DNA techniques (cloning to recombinant protein expression).
- Cell culture, cell proliferation & differentiation, cell death assay.

3. Bioinformatics

- Sequence database mining using bioinformatic software tools. Experience with Incyte blast tools, and Incyte databases, NCBI databases.
- Proteomics technology and protein sequencing.

CONTRIBUTION TO SCIENCE

1. My early publications elucidated the molecular mechanism responsible for lithium's pharmacological actions relevant to its efficacy in treating bipolar disorder. My data from several functional studies were the first to show that lithium has a profound inhibitory effect on protein kinase C (PKC) activation at therapeutic doses. Based on this finding, I hypothesized that PKC is overly activated in CNS and peripheral tissues from bipolar patients and that this over-activation could be used as a biomarker to support the diagnosis of this disorder. This hypothesis was proven correct by the findings that membrane-associated PKC is substantially higher in postmortem brain tissues and blood platelets of bipolar subjects in their manic and euthymic states. Lithium and valproate treatments attenuate such hyperactivated PKC by reducing its Ca^{2+}-dependent cytosol to membrane translocation, the primary activation mechanism for PKC. By providing molecular underpinning and a peripheral state-dependent biomarker for bipolar disorder, this body of work has paved the way to improve the therapeutic efficacy for bipolar disorder treatments. More importantly, this biomarker provides a method of monitoring this disease and therapeutic effects aiming to stabilize bipolar disorder. I served as the primary investigator or co-investigator in all of these studies.

a. Wang HY, Friedman E (1989) Lithium inhibition of PKC activation and activation-induced serotonin release. Psychopharmacol 99: 213-218.
b. Friedman E, Wang HY, Levinson D, Connell TA, Singh H (1993) Altered platelet protein kinase C activity in bipolar affective disorder, manic episode. Biol Psychiatry 33:520-525.

c. Wang HY, Friedman E (1996) Enhanced protein kinase C activity and translocation in bipolar affective disorder brain. Biol Psychiatry 40:568-575.
d. Wang HY, Markwitz P, Levinson D, Undie AS, Friedman E (1999) Increased membrane-associated protein kinase C activity and translocation in blood platelets from bipolar affective disorder patients. J Psychiatric Res 33: 171-179.

2. I investigated the molecular mechanism underlying the long-lasting detrimental effects on cognitive function in offspring of cocaine abuse during pregnancy. My initial efforts led to a discovery that, in contrast to common belief, prenatal cocaine exposure affects specific targets such as D_1 dopamine receptors, leading to distorted dendrites and behavioral dysfunction. More importantly, I observed a substantial increase in membrane-associated protein kinase C (PKC) – similar to that in bipolar disorder – in key brain regions that lasted well into adulthood. Based on this finding and the fact that glutamatergic systems are intimately related to cognitive function, I hypothesized that hyperactivated PKC is the molecular culprit responsible for glutamatergic and hence cognitive dysfunction. This hypothesis was supported by our findings that protracted membrane association of specific PKC isoforms is at least in part responsible for defective AMPA receptor and mGluR1 function. By elucidating the molecular mechanism of glutamatergic dysfunction, this body of work provided a rationale for using agents such as lithium and valproate that reduce excessive PKC activation to treat cognitive problems in prenatal cocaine-exposed individuals. In addition to dramatically alter dopaminergic and glutamatergic neurotransmission, prenatal cocaine exposure also have profound effects on neurotrophin signaling. Using brains from brains from 21-day-old rats that have had exposed to cocaine during gestation, we demonstrate an upregulated BDNF-TrkB signaling by enhancing BDNF binding affinity for TrkB. Since BDNF-TrkB regulates synaptic activity via interacting with NMDARs, these data together indicate the upregulated BDNF-TrkB may be a compensatory response to defects in glutamatergic signaling. I served as the primary investigator or co-investigator in all of these studies. I served as the primary investigator or co-investigator in all of these studies.

a. Wang HY, Runyan S, Yadin E, Friedman E (1995) Prenatal exposure to cocaine selectively affects D_1 dopamine receptor-mediated activation of striatal Gs proteins. J Pharmacol Exp Ther 273:492-498.
b. Jones LB, Stanwood GD, Reinoso BS, Washington RA, Wang HY**,** Friedman E, Levitt P (2000) In Utero cocaine-induced dysfunction of dopamine D_1 receptor signaling and abnormal differentiation of cerebral cortical neurons. J Neurosci 20: 4606-4614.
c. Bakshi K, Gennaro S, Chan CY, Kosciuk M, Liu J, Stucky A, Trenkner E, Friedman E, Nagele RG, Wang HY (2009) Prenatal cocaine reduces AMPA receptor synaptic expression through hyperphosphorylation of the synaptic anchoring protein GRIP. J Neurosci 29: 6308-6319.
d. Bakshi K, Parihar R, Goswami SK, Walsh M, Friedman E, Wang HY (2014) Prenatal cocaine exposure uncouples mGluR1 from Homer1 and Gq proteins. Plus One 9:e91671.
e. Stucky A, Bakshi K, Friedman E, Wang HY (2016) Prenatal cocaine exposure upregulates BDNF-TrkB signaling. Plos One 11 (8):e0160585.

3. To study functional changes in disease brains, I have adapted and fine-tuned functional studies that are typically used in cells and fresh tissues to analyze the signaling and protein-protein interaction in well-characterized diseased and well-matched control postmortem brains with short postmortem intervals. I call this experimental system the *ex vivo stimulation* paradigm. Using this investigation tool, I have identified changes in receptor-mediated signaling and enzymes such as PKC in bipolar brains. I also identified the α7 nicotinic receptor (α7nAChR) as a sub-pM high-affinity receptor for amyloid-β in AD brains. The interaction of amyloid-β with α7nAChR enables subsequent binding of multiple amyloid-β and internalization of the amyloid-β/α7nAChR complexes, accumulation of intracellular amyloid-β and plaque formation. Through binding to α7nAChR, amyloid-β activates several key kinases to promote tau

phosphorylation leading to neurofibrillary lesions and eventual appearance of neurofibrillary tangles. After my discovery that amyloid-β signals via the α7nAChR, many drug discovery programs aimed to disrupt the amyloid-β interaction with α7nAChR to reduce AD pathologies and cognitive impairments. One of such compound identified was S 24795 of Servier Laboratoires in France. Working with PTI, I later discovered that the amyloid-β toxic signaling that leads to neurofibrillary lesions and inflammation requires recruitment of filamin A. This novel finding led us to hypothesize that manipulating filamin A expression or conformation can reduce AD pathogenesis elicited by amyloid-β and thereby normalize synaptic activities and restores cognitive function. More recently, we are the first laboratory to illustrate Filamin A with distorted conformation is intimately involved in AD pathogenesis. This hypothesis was support by the identification of PTI-125 (currently in phase II clinical trial), a small molecule proprietary compound of PTI that binds aberrant filamin A with ultra-high affinity to restore filamin A naïve conformation and reduce AD plaques and neurofibrillary pathologies mouse models and importantly normalizes receptor and synaptic activities in both mouse and human postmortem brain tissues using *ex vivo stimulation* method. More recently, we are the first group to prove experimentally that insulin and IGF-1 receptor signaling defects are prevalently present in AD brains even without diabetes. Such findings indicate that treatment with antidiabetics such as incretin receptor agonists that reduce brain insulin resistance may be effective Alzheimer's disease therapeutics. These studies provide evidence that the *ex vivo stimulation* paradigm using postmortem AD brain tissues is an effective tool to discover broad-spectrum disease-modifying AD therapeutics. The above mentioned target-directed drug discovery programs are accompanied by research efforts on discovery of reliable AD specific diagnostic biomarkers. The effectiveness of AD treatments is closely related to early detection of the disease. These studies have led to identification of potential AD-specific biomarkers such as PTI-125 DX (currently in phase II clinical trial) in the body fluid and peripheral tissues obtained with non-invasive methods. I served as the primary investigator or co-investigator in all of these studies.

a. Wang HY**,** Lee DHS, D'Andrea MR, Peterson PA, Shank RP, Reitz AB (2000) β-Amyloid$_{1-42}$ binds to α7 nicotinic acetylcholine receptor with high affinity: implications for Alzheimer's disease pathology. J Biol Chem 275: 5626-5632.
b. Wang HY**,** Lee DHS, Davis CB, Shank RP (2000) Amyloid peptide Aβ$_{1-42}$ binds selectively and with picomolar affinity to α7 nicotinic acetylcholine receptors. J Neurochem 75: 1155-1161.
c. Wang HY, Li W, Benedetti N, Lee DHS (2003) α7 Nicotinic acetylcholine receptors mediate β-amyloid peptides-induced tau protein phosphorylation. J Biol Chem 278:31547-31553.
d. Wang HY, Stucky A, Liu J, Shen C, Trocme-Thibierge C, Morain P (2009) Dissociating β-amyloid from α7 nicotinic acetylcholine receptor by a novel therapeutic agent, S 24795 normalizes α7 nicotinic acetylcholine and NMDA receptor function in Alzheimer's disease brain. J Neurosci 29: 10961-10973.
e. Wang HY, Bakshi K, Frankfurt M, Stucky A, Goberdhan M, Shah SM, Burns LH (2012) Reducing Amyloid-related Alzheimer's disease pathogenesis by a small molecule targeting filamin A. J Neurosci 32(29): 9773-9784.
f. Talbot K, Wang HY, Kazi H, Han L-Y, Bakshi KP, Stucky A, Fuino RL, Kawaguchi KR, Samoyedny AJ, Wilson RS, Arvanitakis Z, Schneider JA, Wolf BA, Bennett DA, Trojanowski JQ, Arnold SE (2012) Brain insulin resistance demonstrated in Alzheimer's disease without diabetes is associated with dysregulated IRS-1 and implicated in impaired cognition. J Clin Inv 122(4): 1-23. (co-first author)
g. Wang HY, Lee K-C, Pei Z, Khan A, Bakshi K, Burns LH (2017) PTI-125 binds and reverses an altered conformation filamin A to reduce Alzheimer's disease pathogenesis. Neurobiol Aging 55: 99-114.
h. Wang HY, Trocmé-Thibierge C, Stucky A, Shah SM, Kvasic J, Khan A, Morain P, Quignot I, Bouguen E, Deschet K, Pueyo M, Mocaer E, Ousset P-J, Vellas B, Kiyasova V (2017) Increased Aβ42-α7 nicotinic acetylcholine receptor complex level in lymphocyte is associated with

apolipoprotein E4 driven Alzheimer's disease pathogenesis. Alzheimer's Research & Therapy 9:54 (DOI 10.1186/s13195-017-0280-8)

4. Using the *ex vivo stimulation* method, we directly demonstrated a defective NMDA receptor system in schizophrenia relevant to cognitive impairment. We subsequently identified the primary location of the defective NMDA receptor signaling as postsynaptic density and the molecular mechanism responsible for the NMDA receptor hypofunction as enhanced neuregulin- ErbB4 signaling and impaired Src tyrosine kinase. More recently, we identify defects in a metabotropic glutamatergic receptor system, mGluR5 that forms a positive reciprocal interaction loop with NMDARs can contribute to NMDAR hypofunction in schizophrenia. By providing the site and molecular mechanism of NMDA receptor hypofunction, this body of work improves our knowledge of pathogenesis of schizophrenia and enables development of novel therapeutic strategies. One such strategy is repetitive transcranial magnetic stimulation (rTMS) to improve NMDA receptor function and thereby alleviate cognitive impairment in schizophrenia. I served as the primary investigator or co-investigator in all of these studies. Since olfactory neuroepithelial cells derived from biopsy can be cultured and expanded for many generations without losing disease-specific phenotypes, we dedicate our efforts on developing these disease-specific changes into biomarkers for differential diagnosis and monitoring the effectiveness of therapeutic agents. These translational research projects are expected to facilitate novel diagnostic and therapeutic strategies into clinical practices in schizophrenia.

a. Hahn CG, Wang HY, Cho DS, Talbot K, Gur RE, Berrettini WH, Bakshi K, Kamins J, Borgmann-Winter K, Siegel SJ, Arnold SE (2006) Abnormally enhanced neuregulin 1-ErbB4 signaling contributes to NMDA receptor hypofunction in schizophrenia. Nature Medicine 12:824-828. (co-first author)
b. Hahn CG, MacDonald ML, Banerjee A, Cho DS, Kamins J, Nie Z, Borgmann-Winter KE, Grosser T, Pizarro A, Ciccimaro E, Arnold SE, Wang HY, Blair IA (2009) Post-synaptic Density Fractions Obtained from Human Postmortmem Brain Tissues. PloS One 4: e5251.
c. Wang HY, Crupi D, Liu J, Stucky A, Cruciata G, Di Rocco A, Friedman E, Quartarone A, Ghilardi MF (2011) rTMS enhances BDNF-TrkB signaling in both brain and lymphocytes. J Neurosci 31: 11044-11054.
d. Banerjee A, Wang HY, MacDonald ML, Borgmann-Winter KE, Stucky A, Kvasic J, Egbujo C, Talbot K, Hemby SE, Siegel SJ, Arnold SE, Gur RE, Hahn C-G (2014) Src hypoactivity is a convergent mechanism for NMDA receptor hypofunction in schizophrenia. Mol. Psychiatry doi:10.1038/mp.2014. 115. (co-first author)
e. Wang HY, MacDonald ML, Borgmann-Winter KE, Banerjee A, Sleiman P, Tom A, Khan A, Lee K-C, Roussos P, Siegel SJ, Hemby SE, Bilker WB, Gur RE, Hahn C-G. mGluR5 hypofunction is integral to glutamatergic dysregulation in schizophrenia. Mol Psychiatry (In press)
f. Borgmann-Winter K, **Wang HY**, Ray R, Willis BR, Moberg PJ, Rawson NE, Gur RE, Turetsky BI, Hahn CG (2015) Altered G protein coupling in olfactory neuroepithelial cells from patients with schizophrenia. Schizophr Bull doi:10.1093/schbul/sbv129.

RESEARCH GRANTS AND CONTRACTS

CURRENT FUNDED GRANTS AND CONTRACTS:

1. **Translating the function of *C. elegans* APL-1 into understanding the function of human APP.** 4/1/2020-1/31/2022

National Institute of Neurological Disorders and Stroke (Type: 1 R21 AG065890)
Co-PI (PI: Chris Li, Ph.D.) $135,000

2. mGluR5 hypoactivity is integral to glutamatergic dysregulation in schizophrenia.
12/1/2019-3/31/2024
National Institute of Mental Health (Type: 1 R01 MH116463-01)
Co-PI (PI: Chang-Gyu Hahn, MD, Ph.D.) $592,118

3. Treating Alzheimer's disease by reducing insulin resistance with incretin receptor agonists.
5/15/2018-2/28/2023
National Institute on Aging (Type: 1 R01 AG057658)
Co-PI (PI: Konrad Talbot, Ph.D.) $1,091,886

4. Development of PTI-125 DX, a blood-based diagnostic for Alzheimer's disease.
9/15/2017-6/30/2020
National Institute on Aging (Type: STTR 1R42AG057329)
Co-PI (PI: George B. Thorton, Ph.D.) $238,470
Phase I & II clinical trial on AD diagnostic marker

5. Linking peripheral and brain insulin resistance to AD neuropathology and cognition.
2018-2023
National Institute on Aging (Type: RF1AG059621)
Subcontract PI (PI: Zoe Arvanitakis, M.D., M.S) $864,903

6. Open-label extension of a 3-month blinded clinical trial for PTI-125.
08/01/2020-07/31/2022
National Institute on Aging (Type: STTR R44 AG 065152-01)
Subcontract PI (PI: Lindsay Burns, Ph.D.)

7. Multiple Ascending Dose clinical trial of PTI-125, a novel AD therapeutic candidate.
2018-2019
National Institute on Aging (Type: R44 AG 060878)
Subcontract PI (PI: Lindsay Burns, Ph.D.) $118,978
Phase II clinical trial on AD therapeutic candidate

8. Mechanism linking insulin resistance to brain structure, pathology and function.
2014-2019
National Institute of Neurological Disorders and Stroke (Type: R01NS084965)
Subcontract PI (PI: Zoe Arvanitakis, M.D., M.S.)
$300,000/yr

9. Lesion and Activity Dependent Corticospinal Tract Plasticity.
2013-2018
National Institute of Neurological Disorders and Stroke (Type: 2RO1-NS064004-06)
Investigator (PI: John Martin, Ph.D.) $300,000/yr

10. Influence of S 24795 on Aβ42-α7 high affinity interaction, Aβ42-induced tau phosphorylation, and intraneuronal accumulation of Aβ42 using rat brain slice organotypic cultures.

Institut De Recherches Internationales Servier 2005-2020
Principal investigator $10,000/yr

11. Evaluating the effects of NP-101 and other agents on blocking spreading depolarization.
Neuropharmalogic Inc. 2017-2018
$ 11,613

PAST FUNDED GRANTS AND CONTRACTS:

Development of a biomarker assay based on the interaction of filamin A with the α7 nicotinic acetylcholine receptor.
Pain Therapeutics Inc. 2012-2015
Principal investigator $124,822.15/yr

Exploring the anti-cancer potential of PTI's proprietary FLNA-binding compounds.
Pain Therapeutics Inc. 2012-2014
Principal investigator $30,000/yr

Profiling of Alzheimer's disease compounds on high affinity Aβ42 target using rat brain synaptosomes.
Institut De Recherches Internationales Servier 2012-2013
Principal investigator $173,189.96/yr

Pharmacological profiling of Alzheimer's disease compounds on Aβ42-induced tau phosphorylation using rat brain tissues.
Institut De Recherches Internationales Servier 2012-2013
Principal investigator $145,556.66/yr
(Amendment of $145,500 addition pending)

Research of proteinic markers in Alzheimer's disease.
Institut De Recherches Internationales Servier 2012-2013
Principal investigator $58,860/yr

Profiling of Servier compounds on Alzheimer's disease treatment potential using *in vitro* cell-free assays.
Institut De Recherches Internationales Servier 2011-2012
Principal investigator $58,087/yr (renew yearly)

Establishment of a medium throughput cell-free assay.
Institut De Recherches Internationales Servier 2011-2012
Principal investigator $100,000/yr
($10,000/year additional starting on 2013)

Neuronal responsiveness to lithium 2008-2013
National Institute of Mental Health (Type: RO1-MH080193)
Sub-contract collaborator (PI: Chang-Gyu Hahn, M.D., Ph.D.) $34,000/yr

Determination of enhanced basal coupling by receptors in spinal cord corresponding to Neuropathic injury and potential inverse agonists.
Pain Therapeutics Inc. 2005-2012
Principal investigator **$5,000/yr**

Proof of Concept Using Lead Compounds from Medicinal Chemistry. 2009-2012

Pain Therapeutics Inc.
Principal investigator $31,782/yr

Pharmacological profiling of Alzheimer's disease compounds on Aβ42-α7 high affinity interaction, Aβ42-induced tau phosphorylation, and Aβ42-mediated neuronal functions using rat brain slice organotypic cultures.
Institut De Recherches Internationales Servier 2007-2010
Principal investigator

Target identification of ultra-low-dose opioid antagonists in preventing the Mu opioid receptor – G protein coupling switch that occurs in opioid tolerance
Pain Therapeutics Inc. 2005-2010
Principal investigator

Neuregulin 1-erbB4 signaling in schizophrenia 2006-2010
National Institute of Mental Health (Type: RO1)
Sub-contract collaborator (PI: Chang-Gyu Hahn, M.D., Ph.D.)

Prenatal cocaine alters NMDA receptor assembly.
National Institute of Drug Abuse (Type:MIDARP) 2005-2010
Principal investigator (Program director: Eitan Friedman, Ph.D.)

Neuregulin 1- erbB4 – NMDAR signaling in Postmortem Brains
Stanley Foundation 2005-2008
Co-investigator (PI: Chang-Gyu Hahn, M.D., Ph.D.)

Prenatal Cocaine exposure induces AMPA receptor dysfunction.
CUNY Collaborative Incentive grant 2005-2007
Principal investigator

Underlying mechanism of the mu opioid receptor G-protein switch that occurs in opioid Tolerance and its prevention by ultra low dose opioid antagonists.
Pain Therapeutics Inc 2004-2006
Principal investigator

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Intracellular Beta-Amyloid Accumulation and Neuronal Degeneration in Alzheimer's Disease.
Alzheimer's Association. 2003-2006
Co-investigator P.I.: Robert G. Nagele, Ph.D.

Assessment of mu opioid receptor-G protein switching in oxycodone tolerance and neuropathic pain & it prevention by ultra-low-dose naltrexone.
National Institute of Mental Health/STTR 2004-2005
Principal investigator

Assessment of G-Portein coupling and signaling of the mu opioid receptor in morphine naïve And morphine tolerant rats using receptor stimulation by morphine vs morphine + naloxone.
Pain Therapeutics Inc. 2003-2004
Principal investigator

Destruction of the D_1 dopamine receptor and G protein coupling: 1998-2001

molecular mechanism of developmental abnormality induced by prenatal cocaine exposure.
March of Dimes Birth Defects Foundation,
Principal investigator

Age and vascular α1-adrenoceptor functional coupling. 1997-1999
National Institute of Aging,
Principal investigator

G proteins in desensitized vascular smooth muscle. 1995-1997
Alleghny-Singer Research Institute,
Principal investigator

Altered receptor-G protein coupling: 1995-1997
molecular mechanism of hypertension.
American Heart Association, Southeastern Pennsylvania Affiliate,
Principal investigator

Brain Structure and Function after Fetal Cocaine Exposure.
National Institute on Drug Abuse 1990-1994
Investigator PI: J. Harvey, Ph.D.

Neural, Endocrine, and Gastric Changes Induced by
Immobilization Stress. 1992-1993
Ciba-Geigy corperation,
Principal investigator

Alzheimer's Disease Related Alterations in Serotonin Receptors-
G Proteins Interation. 1992-1993
Alleghny-Singer Research Institute,
Principal investigator

Dopamine-linked phosphoinositide metabolism in brain. 1991-1995
National institute of Neurological disorders and Stroke 1996-2000
Investigator P.I. Eitan Friedman, Ph.D.

Effect of Age on Serotonin-Induced G Protein Activation. 1991-1992
Center for Gerontological Research,
Principal investigator

Protein kinase C in Mania and in Lithium's Actions. 1989-1994
National Institute of Mental Health
Co-investigator PI: E. Friedman, Ph.D.

Aging, Protein kinase C and Serotonin Release. 1988-1993
National Institute of Aging 1993-1998
Co-investigator PI: E. Friedman, Ph.D.

The Effect of Age on Human Protein kinase C. 1989-1990
American Federation for Aging Research (AFAR),

Principal investigator

Role of Protein Kinase C in Aging. 1988-1989
American Federation for Aging Research (AFAR),
Co-investigator PI: Jupiter Yeung, Ph.D.

Protein Kinase C in Alzheimer's Disease. 1988-1989
Alzheimer's Disease and Related Disorders Associations, Inc.(ADRDA)
Principal investigator

PENDING RESEARCH GRANTS AND CONTRACTS
Project Number: 1R01AG076124-01
PIs: Hussein Yassine, Hoau-Yan Wang, Zoe Arvanitaki
Title: **Brain cPLA2 as a mechanism for neuroinflammation in AD/ADRD with and without APOE4**

Project Number: R41 NS 108830
PI: Hoau-Yan Wang, Ph.D
Source: NIDDS
Title: **A natural product PP2A inhibitor for the treatment of migraine.**
The primary goal of this study is to determine whether blocking cortical spreading depolarization by a natural product
PP2A inhibitor can be therapeutically beneficial to treat migraine.
Dates of proposed project: 09/1/2018-02/28/2020
Annual Direct costs: $89,172

Project Number:
Co-PI: Hoau-Yan Wang, Ph.D **PI: Lindsay Burns, Ph.D.**
Source: NCI
Title: **PTI-910, a novel small molecule that suppresses mTOR and K-RAS by binding filamin A.**
The primary goal of this study is to determine the anti-cancer therapeutic efficacy of the PTI-910 in a preclinical setting.
Dates of proposed project: 04/1/2019-03/31/2020

Annual Direct costs: $48,059
Effort: 0.5 Academic
No budgetary and scientific overlap

PATENTS

1. Alzheimer’s disease assay in living patients
   US Patent No.: 11,385,221 (7/12/2022)
   Author: **Wang HY**, Burns Barbier LH
   An assay for Alzheimer's disease (AD) pathology in a living patient is disclosed wherein an amount of α7nAChR or TLR4 in a FLNA-captured protein complex or α7nAChR in an Aβ-captured protein complex or α7nAChR-FLNA, or TLR4-FLNA and/or α7nAChR-Aβ42 complex present as a protein-protein complex in a sample is compared to the amount in a standard sample from a person free of AD pathology. An amount greater than in the standard

sample indicates AD pathology. Also disclosed is an assay predictive of prognosis for treatment with a medicament in which the amount of an above protein or protein complex is compared to an amount in the presence of a medicament that binds to a FLNA pentapeptide and contains at least four pharmacophores of FIGS. 7-12. An amount of protein or protein complex determined in the presence of medicament that is less than the first amount indicates a favorable treatment prognosis.

2. Method for inhibiting growth of cancer cells

US Patent No: 10363239 (7/30/2019)

Author: Wang HY, Burns Barbier LH

This patent describes a method of inhibiting the growth of cancer cells is disclosed in which cancer cells that contain an enhanced amount relative to non-cancerous cells of one or more of phosphorylated mTOR, Akt1, ERK2 and serine2152-phosphorylated filamin A are contacted with an FLNA-binding effective amount of a compound or a pharmaceutically acceptable salt thereof that binds to the pentapeptide of filamin A (FLNA) of SEQ ID NO: 1 and exhibits at least about 60 percent of the FITC-labeled naloxone binding amount when present at a 10 ?M concentration and using unlabeled naloxone as the control inhibitor at the same concentration. A compound that binds to the FLNA pentapeptide preferably also contains at least four of the six pharmacophores of FIGS. 19-24.

3. Alzheimer’s disease assay in living patients

US Patent No.: 10,222,368 (3/5/2019)

Author: **Wang HY**, Burns Barbier LH

This patent describes an assay for Alzheimer's disease (AD) pathology in a living patient is disclosed wherein an amount of α7nAChR or TLR4 in a FLNA-captured protein complex or α7nAChR in an Aβ-captured protein complex or α7nAChR-FLNA, TLR4-FLNA and/or α7nAChR-Aβ42 complex present as a protein-protein complex in a sample is compared to the amount in a standard sample from a person free of AD pathology. An amount greater than in the standard sample indicates AD pathology. Also disclosed is an assay predictive of prognosis for treatment with a medicament in which the amount of an above protein or protein complex is compared to an amount in the presence of a medicament that binds to a FLNA pentapeptide and contains at least four pharmacophores.

4. Method for inhibiting tau phosphorylation

US Patent No.: 10,017,736 (7/10/2018)

Author: **Wang HY**, Burns Barbier LH

This patent describes a method of inhibiting phosphorylation of the tau protein and/or a TLR4-mediated immune response is disclosed. The method contemplates administering to cells in recognized need thereof such as cells of the central nervous system an effective amount of a of a compound or a pharmaceutically acceptable salt thereof that binds to a pentapeptide of filamin A (FLNA) of SEQ ID NO: 1, and contains at least four of the six pharmacophores of FIGS. 35-40.

5. Alzheimer’s disease assay in living patients

US Patent No.: 9,500,640 (11/22/2016)

Author: **Wang HY**, Burns Barbier LH

This patent describes an assay for Alzheimer's disease pathology in a living patient wherein the α7nAChR/FLNA, TLR4/FLNA and/or α7nAChR/Aβ42 complex levels as the predictive of prognosis for treatments.

6. Method for inhibiting growth of cancer cells
US Patent No.: 9,433,604 (9/26/2016)
Author: **Wang HY**, Burns Barbier LH
A method of inhibiting the growth of cancer cells is disclosed in which cancer cells that contain an enhanced amount relative to non-cancerous cells of one or more of phosphorylated mTOR, Akt1, ERK2 and serine2152-phosphorylated filamin A are contacted with an FLNA-binding effective amount of a compound or a pharmaceutically acceptable salt thereof that binds to the pentapeptide of filamin A (FLNA) of SEQ ID NO: 1 and exhibits at least about 60 percent of the FITC-labeled naloxone binding amount when present at a 10 ?M concentration and using unlabeled naloxone as the control inhibitor at the same concentration. A compound that binds to the FLNA pentapeptide preferably also contains at least four of the six pharmacophores of FIGS. 19-24.

7. Alzheimer's disease assay in living patients
US Patent No.: 9,354,223 (5/31/2016)
Author: **Wang HY**, Burns Barbier LH
This patent describes an assay for Alzheimer's disease pathology in a living patient wherein the α7nAChR/FLNA, TLR4/FLNA and/or α7nAChR/Aβ42 complex levels are greater than standard samples to indicate Alzheimer's disease.

8. Filamin A binding anti-inflammatory and analgesic.
US Patent No.: 9,340,558 (5/7/2016)
Author: Burns Barbier LH, **Wang HY**, Lin N-H, Blasko A.
This patent describes a novel class of powerful anti-inflammatory and/or mu opioid receptor agonistic analgesic agents that bind with high affinity to filamin A. Unlike the existing narcotics, these analgesic agents produce minimal tolerance and dependence.

9. Analgesia with minimal tolerance and dependence by a mu opioid receptor agonist that also binds filamin A.
US Patent No.: 8,722,851 (5/13/2014)
Author: **Wang HY**, Burns Barbier LH, Wang J.
This patent describes a novel class of analgesic agents that are agonists of the mu opioid receptor and bind with high affinity to filamin A. Unlike the existing narcotics, these analgesic agents produce minimal tolerance and dependence.

10. Filamin A binding anti-inflammatory and analgesic.
US Patent No.: 8,653,068 (2/18/2014)
Author: Burns Barbier LH, **Wang HY**, Lin N-H, Blasko A.
This patent describes another novel class of powerful anti-inflammatory and/or mu opioid receptor agonistic analgesic agents that bind with high affinity to filamin A. Unlike the existing narcotics, these analgesic agents produce minimal tolerance and dependence.

11. Filamin A binding anti-inflammatory and analgesic.
US Patent No.: 8,614,324 (12/24/2013)
Author: Burns Barbier LH, **Wang HY**, Lin N-H, Blasko A.
This patent describes another novel class of powerful anti-inflammatory and/or mu opioid receptor agonistic analgesic agents that bind with high affinity to filamin A. Unlike the existing narcotics, these analgesic agents produce minimal tolerance and dependence.

12. Filamin A binding anti-inflammatory and analgesic.
US Patent No.: 8,580,809 (11/12/2013)
Author: Burns Barbier LH, **Wang HY**, Lin N-H, Blasko A.
This patent describes another novel class of powerful anti-inflammatory and/or mu opioid receptor agonistic analgesic agents that bind with high affinity to filamin A. Unlike the existing narcotics, these analgesic agents produce minimal tolerance and dependence.

13. Filamin A binding anti-inflammatory and analgesic.
US Patent No.: 8,580,808 (11/12/2013)
Author: Burns Barbier LH, **Wang HY**, Lin N-H, Blasko A.
This patent describes another novel class of powerful anti-inflammatory and/or mu opioid receptor agonistic analgesic agents that bind with high affinity to filamin A. Unlike the existing narcotics, these analgesic agents produce minimal tolerance and dependence.

14. Analgesia with minimal tolerance and dependence by a mu opioid receptor agonist that also binds filamin A.
US Patent No.: 8,492,349 (7/23/2013)
Author: **Wang HY**, Burns Barbier LH, Wang J.
This patent describes a novel class of analgesic agents that are agonists of the mu opioid receptor and bind with high affinity to filamin A. Unlike the existing narcotics, these analgesic agents produce minimal tolerance and dependence.

15. Methode de criblage de composes aux proprietes anti-amyloide (Screening method of anti-amyloid compounds)
Patent No.: n°06/07385
Authors: **Wang HY**, Morain P, Thibierge C
This patent describes a novel method to select compounds that may retard β-amyloid induced neuronal dysfunction. The compounds identified through this screening program may be used to treat neurodegenerative diseases with amyloid pathologies including Alzheimer's disease and Down syndrome.

16. Method for treating neurodegenerative disorders
Patent No.: 7,018,797 (3/28/2006)
Authors: Reitz AB, Demeter DA, Lee DHS, **Wang HY**, Chen RH, Morgan Ross T, Scott MK, Plata-Salaman CR
This patent describes a novel method of treating a neurodegenerative disorder by inhibiting the interaction between Amyloid β and α7 nicotinic receptor.

17. Method of treating neurodegenerative disorders via inhibition of amyloid β binding.
Patent No.: 6,441,049

Authors: Reitz AB, Demeter DA, Lee DHS, **Wang HY**, Chen RH, Morgan Ross T, Scott MK, Plata-Salaman CR
This patent describes a novel method of treating a neurodegenerative disorder by inhibiting Amyloid β binding.

18. ErbB4 as a therapeutic target of psychotic illnesses
Penn T4328 application
Author: Hahn CG, **Wang HY**, Arnold S.
This patent describes a novel therapeutic approach to reduce psychotic episodes by reducing ErbB4 signaling.

INVITED PRESENTATION:

09/2019 VI International Workshop on Nitric Oxide in Cancer and Beyond
New York, USA
NMDA receptor-mediated signaling and activation of NOS in healthy human glia and glial tumors

04/2018 The 15th World Congress of the Society for Brain Mapping and Therapeutics
Los Angeles, USA
Reducing amyloid-related Alzheimer's disease pathogenesis by a small molecule targeting filamin A

09/2017 NYU Joint Fresco Institute & Neuroscience Research Meeting
New York, USA
Fluid biomarkers to tract Parkinson's disease progression

06/2015 NYC visiting fellowship in transcranial Magnetic Stimulation
New York, USA
Molecular effects of TMS in animals

07/2012 Alzheimer Association International Conference
Vancouver, Canada
PTI-125 reduces amyloid-related Alzheimer's pathogenesis by targeting filamin A.

03/2011 Institut De Recherches Internationales Servier
Croissy-Sur-Seine, France
Impaired Insulin Signaling in Hippocampal Formation of the Alzheimer's disease cases.

04/2010 The first international workshop on synaptic plasticity from bench to bed side.
Taomina, Italy
TMS-induced plasticity in an animal model: mechanisms of action

03/2010 Institut De Recherches Internationales Servier
Croissy-Sur-Seine, France
The Hunt for β-Amyloid - α7 Nicotinic Receptor Complex Breakers to Treat Alzheimer's disease.

06/2006 Workshop-"The Continuum between MCI and Alzheimer's Disease": From Physiopathology to Clinical and Regulatory Approaches.
Versailles, France
Nicotinic receptor and β-Amyloid

02/2005 Chemistry department, Stevens Institute of Technology
New Jersey, USA
A neuronal receptor for β-amyloid in our minds: Therapeutic implications for Alzheimer's disease treatments.

11/2004 Biology Colloquium, Biology department, City College of New York
New York, USA
A neuronal receptor for β-amyloid in our minds: Therapeutic implications for Alzheimer's disease treatments.

07/2004 Biomedical and pharmaceutical science center, China Medical University.
Taiwan
The role for β-amyloid in mediating Alzheimer's disease pathogenesis.

03/2002 Biochemistry seminar, Chemistry department, City College of New York
New York, USA
Pathway to neurodegeneration in Alzheimer's disease: The role of a neuronal receptor for β-amyloid.

07/2000 Graduate school of Pharmaceutical Sciences, China Medical University
Taiwan
Current development in pharmacotherapy for Alzheimer's disease.

09/1999 Johnson & Johnson annual research symposium
New Jersey, USA
α7 Nicotinic receptor as the target for Alzheimer's disease treatment.

CONSULTANCY AND SCIENTIFIC ADVISORY BOARDS:

1. **Institut De Recherches Internationales Servier** (Drug discovery, preclinical development)

2. **Cassava Sciences.** (Scientific advisory board member, drug discovery & Preclinical development)

3. **Neuropharmalogic, Inc.** (Scientific advisory board member, drug discovery & preclinical development)

PROFESSIONAL ORGANIZATIONS:

New York Academy of Science
Society for Neuroscience
American Society for Pharmacology and Experimental Therapeutics
Mid-Atlantic Pharmacology Society

Dept. of Molecular and Cell Biology, Harvard University, Affiliate member, CAP

JOURNAL REVIEWER:
J. Neurosci., J. Pharmacol. Exp. Ther., Eur. J. Pharmacol., J. Neurochem., Biol. Psychiatry, J. Gerontol. Bipolar disorder, Exp. Neurol., Pharmacol. Biochem. Behav. Brain Research, J Nuclear Med,

GRANT REVIEWER:
Israel Science Foundation
Bi-National Science Foundation
New Zealand Neurological Foundation
Alzheimer's Foundation
PSC-CUNY
New Jersey Cancer research commission
Israel Science Foundation

TEACHING AND MANGERIAL EXPERIENCE:
Lectured in Medical Pharmacology course to medical and graduate students.
Lectured in Medical Physiology course to medical students
Lectured in Molecular Cell Biology course to medical students
Course director of graduate course, Neuropharmacology of neuro-pyschological disorders.
Course director of Pharmacology course to Physician Assistant students.
Lectured in Neuroscience graduate course
Lectured in Pharmacology course (neuropharmacology) to nurse practitioners.
Supervising research projects of numerous graduate students and post-doctoral research fellows.
Serve as a thesis committee member for graduate students.

GRADUATE STUDENTS UNDER SUPERVISION:
Kalindi Bakshi
Andres Stucky
Jingjing Liu
Marissa Goberdhan
Amber Khan

COMMITTEE SERVICES:

Member of bio-safety committee	MCP-Hahnemann University	1996-1997
Member of Step 2 committee (Cell biology curriculum)	CUNY Medical School	2002
Member of Rudin Fellowship committee	CUNY Medical School	2004-
Member of Curriculum committee	CUNY Medical School	2005-2010
Member of Academic progress committee	CUNY Medical School	2010-
Member of Library Committee	CUNY Medical School	2010-
Member of Radiation safety committee	CCNY	2005-
Member of Molecular biology and Biochemistry Panel	CUNY	2007-
Member of Graduate center Faculty Review panel	CNUY Graduate Center	2015-

PUBLICATIONS:

Articles

1. Robinson S., Mogul AS, Taylor-Yeremeeva EM, Khan A, Tirabassi AD, **Wang HY** (2021) Stress diminishes BDNF-stimulated TrkB signaling, TrkB-NMDA receptor linkage and neuronal activity in the rat brain. Neuroscience 473:142-158.

2. Arvanitakis Z, Capuano, AW, **Wang HY**, Schneider JA, Bennett DA, Ahima RS, Arnold SE (2021) Brain insulin signaling and cerebrovascular disease in human postmortem brain. Acta Neuropathologica Comm 9:71.

3. Meade GM, Charron LS, Kilburn LW, Pei Z, **Wang HY**, Robinson S (2021) A model of negative emotional contagion between male-female rat dyads: effects of voluntary exercise on stress-induced behavior and BDNF-TrkB signaling. Physiol & Behav 234: 113286.

4. Arvanitakis Z, **Wang HY**, Capuano AW, Khan A, Taib B, Anokye-Danso F, Schneider JA, Bennett DA, Ahima RS, Arnold, SE (2020) Brain insulin signaling, Alzheimer's disease pathology, and cognitive function. Annals Neurology 88: 513-525.

5. Pei Z, Lee K-C, Khan A, Erisnor G, **Wang HY** (2020) Pathway analysis of glutamate-mediated, calcium-related signaling in glioma progression. Biochemical Pharmacology 176: 113814

6. **Wang HY**, Pei Z, Lee K-C, Lopez-Brignoni E, Nikolov B, Crowley CA, Marsman MR, Barbier R, Friedmann N, Burns LH (2020). PTI-125 Reduces Biomarkers of Alzheimer's Disease in Patients. J Prev Alzheimers Dis. 7: 256-264.

7. Pei, Z, Lee K-C, Khan A, **Wang HY** (2019) Hyper-activated insulin signaling cascade in human glioblastoma cells. Critical Rev Oncog 24: 243-250.

8. **Wang HY**, Capuano AW, Khan A, Pei Z, Lee K-C, Bennett DA, Ahima RS, Arnold SE, Arvanitakis Z (2019) Insulin and adipokine signaling and their cross-regulation in postmortem human brain. Neurobiol Aging 84: 119-130.

9. **Wang HY**, MacDonald ML, Borgmann-Winter KE, Banerjee A, Sleiman P, Tom A, Khan A, Lee K-C, Roussos P, Siegel SJ, Hemby SE, Bilker WB, Gur RE, Hahn C-G (2018). mGluR5 hypofunction is integral to glutamatergic dysregulation in schizophrenia. Mol Psychiatry doi: 10.1038/s41380-018-0234-y.

10. Arnold SE, Arvanitakis Z, Macauley-Rambach S, Koening A, **Wang HY**, Ahima R, Craft S, Gandy S, Buettner C, Stoeckel L, Holtzman D, and Nathan D (2018) Brain insulin resistance in type 2 diabetes and Alzheimer's disease: Concepts and conundrums. Nature Rev Neurol 14:168-181.

11. Burns LH and **Wang HY** (2017) Altered filamin A enables Aβ-induced tau hyperphosphorylation and neuroinflammation in Alzheimer's disease. Neuroimmunol Neuroinflammation 4:263-271.

12. Rajan TS, Ghilardi MF, **Wang HY**, Mazzon E, Bramanti P, Restivo D, Quartarone A (2017) Mechanism of action for rTMS: a working hypothesis based on animal studies. Frontiers in Physiol (doi: 10.3389/fphys.2017.00457)

13. **Wang HY**, Lee K-C, Pei Z, Khan A, Bakshi K, Burns LH (2017) PTI-125 binds and reverses an altered conformation filamin A to reduce Alzheimer's disease pathogenesis. Neurobiol Aging 55: 99-114.

14. Borgmann-Winter K, **Wang HY**, Ray R, Willis BR, Moberg PJ, Rawson NE, Gur RE, Turetsky BI, Hahn CG (2015) Altered G protein coupling in olfactory neuroepithelial cells from patients with schizophrenia. Schizophr Bull doi:10.1093/schbul/sbv129.

15. Fontanesi C, Kvint S, Frazzitta G, Bera R, Ferrazzoli D, Di Rocco A, Rebholz H, Friedman E, Pezzoli G, Quartarone A, **Wang HY**, Ghilardi MF (2015) Intensive rehabilitation enhances lymphocyte BDNF-TrkB signaling in patients with Parkinson's disease. Neurorehabilition & Neuronal Repair DOI: 10.1177/1545968315600272.

16. Banerjee A, **Wang HY**, MacDonald ML, Borgmann-Winter KE, Stucky A, Kvasic J, Egbujo C, Talbot K, Hemby SE, Siegel SJ, Arnold SE, Gur RE, Hahn C-G (2015) Src hypoactivity is a convergent mechanism for NMDA receptor hypofunction in schizophrenia. Mol. Psychiatry 20: 1091-1100 (doi:10.1038/mp.2014.115) ***Jointed first authors***

17. Talbot K, **Wang HY** (2014) The nature, significance, and GLP-1 analogue treatment of brain insulin resistance in Alzheimer's disease. Alzheimer's & Dementia 10: S12-S25. [review]

18. Yan H, Xu T, Lee K-C, **Wang HY**, Zhang Y (2013) Isoflurane increases neuronal cell death by downregulating miR-214. Plus One 8(2): e55276.

19. **Wang HY**, Bakshi K, Frankfurt M, Stucky A, Goberdhan M, Shah SM, Burns LH (2012) Reducing Amyloid-related Alzheimer's disease pathogenesis by a small molecule targeting filamin A. J Neurosci 32(29): 9773-9784.

20. Talbot K, **Wang HY**, Kazi H, Han L-Y, Bakshi KP, Stucky A, Fuino RL, Kawaguchi KR, Samoyedny AJ, Wilson RS, Arvanitakis Z, Schneider JA, Wolf BA, Bennett DA, Trojanowski JQ, Arnold SE (2012) Brain insulin resistance demonstrated in Alzheimer's disease without diabetes is associated with dyregulated IRS-1 and implicated in impaired cognition. J Clin Inv 122(4): 1-23. ***co-first authors***

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23. **Wang HY**, Stucky A, Hahn C-G, Wilson RS, Bennett DA, Arnold S (2011) BDNF-TrkB signaling in late life cognitive decline and Alzheimer's disease. Translational Neurosci 2: 91-100.

24. Burns LH and **Wang HY** (2010) Ultra-Low-Dose Naloxone or Naltrexone to Improve Opioid Analgesia: The History, the Mystery and a Novel Approach. Clinical Medicine Insights: Therapeutics 2: 857–868.

25. Burns LH and **Wang HY** (2010) PTI-609: A novel analgesic agent that binds filamin A to control opioid signaling. Recent Patents on CNS Drug Discovery 5: 210-220.

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36. Battaglia F, **Wang HY**, Gilardi MF, Gashi E, Quartarone A, Friedman E, Nixon RA (2007) Cortical plasticity in Alzheimer's disease in humans and rodents. Biol Psychiatry 62: 1405-1412. ***co-first authors***

37. Hahn CG, **Wang HY,** Cho DS, Talbot K, Gur RE, Berrettini WH, Bakshi K, Kamins J, Borgmann-Winter K, Siegel SJ, Arnold SE (2006) Abnormally enhanced neuregulin 1-ErbB4 signaling contributes to NMDA receptor hypofunction in schizophrenia. Nature Medicine 12:824-828. ***Jointed first authors***

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44. Nagele RG, D'Andrea MR, Lee H, Vekataraman V, **Wang HY** (2003) Astrocytes accumulate Aβ42 and give rise to astrocytic amyloid plaques in Alzheimer's disease brains. Brain Res 971:197-209.

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53. Seasholtz TM, Cai GP, **Wang HY,** Friedman E (2001) Ischemia-reperfusion decreases norepinephrine release and increases α-adrenoceptor-mediated contraction and inositol phosphate accumulation associated with increased coupling of α_{1a}-adrenoceptors to $G_{\alpha q}$ in the rat tail artery. J Appl Physiol 91: 1004-1010.

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63. **Wang HY,** Lee DHS, D'Andrea MR, Peterson PA, Shank RP, Reitz AB (2000) β-Amyloid$_{1-42}$ binds to α7 nicotinic acetylcholine receptor with high affinity: implications for Alzheimer's disease pathology. J Biol Chem 275: 5626-5632.

One of the 63 milestone papers in Alzheimer's disease research in year 2000 (selected from > 3000 published manuscripts by Alzheimer Forum).

64. **Wang HY**, Lee DHS, Wild KD, Shank RP (1999) Galanin inhibits acetylcholine release from rat cerebral cortex via a pertussis toxin-sensitive G_i protein. Neuropeptides 33: 197-205.

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Abstracts

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EXHIBIT 2

CURRICULUM VITAE – PAUL S. BROOKES, PhD

OVERVIEW

- Continual NIH R01 funding since 2003 (R01 HL-071158)
- 157 papers (121 original articles, 36 book chapters & reviews), Scopus *h*-index = 63
- 70+ invitations to speak at outside institutions & conference plenary lectures.
- ~40 teaching contact hrs/yr, mentored 6 PhD students, 5 post-doc' fellows.

WORK ADDRESS

Department of Anesthesiology, Box 604, **www.psblab.org**
University of Rochester Medical Center,
601 Elmwood Avenue, Rochester, NY 14642, USA
Tel: (585) 273-1626 E-mail: paul_brookes@urmc.rochester.edu

HOME ADDRESS

[redacted]

PERSONAL

[redacted]

EDUCATION

B.Sc. (1993)	Department of Biochemistry, University College London, UK Biochemistry. Upper 2nd class honors.
Ph.D. (1997)	Department of Biochemistry, University of Cambridge, UK Thesis: *"The proton leak and fatty acid composition of mitochondrial inner membrane phospholipid liposomes"*. Mentor: Martin D. Brand.
MBA (2026 expected)	Simon Business School, University of Rochester, Rochester NY Part-time Executive MBA program

FELLOWSHIPS

1997 – 1998	Institute of Neurology, University College London, UK Post-Doctoral Fellow with John B. Clark & Simon J.R. Heales.
1998 – 2001	Department of Pathology, Univ. Alabama at Birmingham, USA Post-Doctoral Fellow with Victor M. Darley-Usmar & Peter G. Anderson.

FACULTY APPOINTMENTS

2001 – 2002	Department of Pathology, Univ. Alabama at Birmingham, USA Research Instructor
2002 – 2003	Department of Pathology, Univ. Alabama at Birmingham, USA Research Assistant Professor
2003 – 2008	Department of Anesthesiology, University of Rochester, NY, USA Assistant Professor (Secondary, Pharmacology & Physiology)
2008 – 2015	Department of Anesthesiology, University of Rochester, NY, USA Associate Professor with tenure (Secondary, Pharmacology & Physiology)
2015 –	Department of Anesthesiology University of Rochester, NY, USA

Professor with tenure (Secondary, Pharmacology & Physiology)

RESEARCH SUMMARY

My 30+ years in bioscience research has focused on mitochondria and metabolism. Currently my lab studies metabolism in cardiac ischemia-reperfusion (IR) injury and cardioprotection. We use isolated cardiomyocytes, perfused hearts, and whole animal models, coupled with biochemical methods and metabolite profiling by LC/MS. Key interests include: (i) The role of acidic pH in IR injury as a protective metabolic remodeling signal. (ii) Methylglyoxal metabolism. (iii) High-throughput screening and development of mitochondrially-targeted drugs. (iv) Reversal of electron transfer in mitochondrial respiratory chain complexes. Our overall goal is to understand metabolic events during acute IR injury, and to target these events for therapeutic benefit.

RESEARCH INTEGRITY

In 2010 I discovered fabricated data in a grant application, triggering a prolonged interest in research integrity. In 2012 I launched the anonymous blog science-fraud.org, which reported on almost 300 papers from 75 labs. I was forced to close the site after my identity was revealed and 6 scientists threatened to sue for defamation (none succeeded). A paper ensued, regarding the impact of internet publicity on how problem papers are addressed. I continue to write on research integrity at my lab' website psblab.org and post on pubpeer.com, and to date my efforts have resulted in hundreds of retractions and several misconduct findings by the federal Office of Research Integrity (ORI). My curated database of image manipulation has been used as a training set by those developing AI detection tools, which I have beta tested. In addition to teaching research ethics and being vice-chair of the animal use committee (UCAR/IACUC), I have served as an invited speaker and ad-hoc consultant on research integrity. I am also a strong proponent of open-science to combat misconduct, recently overseeing adoption of an Open-Access publication policy by the university. Since 2016 my lab has posted pre-prints on BioRxiv and full data sets on FigShare.

SOCIETY MEMBERSHIPS

1993 –	Member, Biochemical Society, UK
1999 –	Member, Society for Free Radical Biology & Medicine (SfRBM). Council member 2006-2012. VP for Education & Professional Development 2009-2012
2006 –	Professional Member, American Heart Association
2011 – 2017	Member, American Society for Biochemistry & Molecular Biology
2018 – 2021	Member, American Diabetes Association

CAREER AWARDS

1999	Postdoctoral Fellowship, American Heart Association Southeast Affiliate.
1999	Young Investigator Award, 6th Annual Meeting, Society for Free Radical Biology & Medicine (SfRBM).
2004	Italian Finance Ministry. 1 month visiting professorship at University of Rome La Sapienza, €2850.

2006 United Mitochondrial Disease Foundation, Linnane Award for mitochondrial research.
2011 NHLBI Mitochondrial Symposium, Poster/Travel Award.
2012 SfRBM Distinguished Service Award
2012 Fellow of the American Heart Association
2020 Fellow of the SfRBM

FUNDING

A. AS PRINCIPAL INVESTIGATOR

ACTIVE:

R01 HL-071158 (now in 5th cycle) 3/1/22–3/30/26
National Institutes of Health, NHLBI
"Acid, Succinate and Glyoxal Metabolism in Cardiac Ischemia"

PREVIOUS:

R01 HL-071158 (4th cycle) 7/1/17–6/30/21
National Institutes of Health, NHLBI
"SIRT1, Acidosis & Metabolism in Cardioprotection"

R01-HL071158 (3rd cycle) 5/1/13–6/30/17
National Institutes of Health, NHLBI
"SIRT1 & Nitro-Lipids in Cardioprotection"

R01 HL-071158 (2nd cycle) 1/1/08–12/31/12
National Institutes of Health, NHLBI
"Mitochondria & NO• in cardiac ischemic preconditioning."

R01 HL-071158 (1st cycle) 8/1/03–7/31/07
National Institutes of Health, NHLBI
"Mitochondria & NO• in cardiac ischemia-reperfusion."

R56 DK-126659 9/15/20-8/31/21
National Institutes of Health, NIDDK
"Mitochondrial Potassium Channels as Obesity Drug Targets"

R01 HL-127891 4/1/15–4/30/19
National Institutes of Health, NHLBI
"The Mitochondrial Unfolded Protein Response (mtUPR) & Cardioprotection"
(Multi P.I. with Keith W. Nehrke, Cole P Haynes)

R01 GM-087483 (2nd cycle) 1/1/10–4/30/18
National Institutes of Health, NIGMS
"Mitochondrial K^+ channels & Cardioprotection"
(Dual P.I. with Keith W. Nehrke)

R01 GM-087483 (1st cycle) 1/1/10–12/31/13
National Institutes of Health, NIGMS
"C. elegans and Mitochondrial K^+ channels"

(Dual P.I. with Keith W. Nehrke)

Beginning Grant-In-Aid #0160174B 7/1/01–6/30/03
AHA Southeast Affiliate
"The interplay between reactive nitrogen species & mitochondrial protein thiols."

Intramural Pilot Study Grant 7/1/01–6/30/02
UAB Clinical Nutrition Center
"Post-transcriptional regulation of mitochondrial uncoupling proteins: implications for obesity."

Post-Doctoral Fellowship Award 7/1/99–6/30/01
AHA Southeast Affiliate
"Mitochondria and NO• in cardiac hypertrophy"

Consulting/Collaboration Agreement 12/1/09–12/1/10
Galleon Pharmaceuticals Inc.
"Effect of proprietary compounds on cardiac mitochondrial function"

FUNDING

B. AS CONSULTANT OR CO-INVESTIGATOR

ACTIVE:

R01AG080188 5/1/24–4/30/29
National Institute of Aging, NIA
PI: Roman Eliseev My Role: Co-Investigator (3%)
"Energy Metabolism in Osteoblasts and Bone Health"

R21AR080291 9/20/22–8/31/24
National Institutes of Health, NIARMSD
PI: Roman Eliseev My Role: Co-Investigator (5%)
"Mitochondrial genetics as a determinant of bone health"

R01 DK136064 (PI: Thu Le) 10/1/23-9/30/25
National Institutes of Health, NIDDK
PI: Thu Le My Role : Co-Investigator (5%)
"GSTM1 Transulfuration Metabolic Axis in Kidney Disease - Therapeutic Target in Precision Medicine"

PREVIOUS:

R01 HL144776 7/15/19–6/30/23 (in NCE)
National Institutes of Health, NHLBI
PI: George Porter My Role: Co-Investigator (5%)
"Cyclophilin D regulates neonatal cardiac bioenergetics and function"

NPF Biomarker Discovery Grant 8/1/19–7/31/21
National Psoriasis Foundation
PI: Ananta Paine My Role: Co-Investigator (5%)

"Metabolomics Biomarkers for Psoriatic Arthritis"

R01 HL067392 7/1/11–6/31/15
National Institutes of Health, NHLBI
PI: Michael A O'Reilly, PhD. My Role: Co-Investigator (5%)
"Cell Survival And Death In Oxidant Lung Injury"

P01 GM066730 7/1/09–6/30/14
National Institutes of Health, NHLBI
PI: Zelijko Bosnjak PhD. My Role: External advisory board (0%)
"Mitochondria & Anesthetic preconditioning"

1P50 CA130805 09/01/08–08/31/13
National Institutes of Health, NCI 5% Effort
PI: Richard Fisher, MD. My Role: Co-Investigator, project 2 (5%)
"SPORE in Lymphoma"

R01 NS041744 8/1/09–7/31/12
National Institutes of Health, NINDS
PI: Gail V. Johnson, PhD. My Role: Co-investigator (5%)
"Mutant Huntingtin Compromises Mitochondrial Function"

R01 HL080704 1/1/07–12/31/10
National Institutes of Health
PI: David D. Gutterman, MD, PhD. My Role: Consultant (0%)
"Flow-Mediated Dilation of Human Coronary Arterioles"

Mantle Cell Lymphoma Grant 5/1/07–8/31/08
Lymphoma Research Foundation (LRF)
PI: Steven Bernstein, MD. My Role: Co-investigator (5%)
"Triterpenoids as Novel Therapeutic Agents for Mantle Cell Lymphoma"

R01 NS041744 7/1/02–6/30/07
National Institutes of Health, NINDS
PI: Gail V. Johnson, PhD. My Role: Co-investigator (10%)
"Mutant Huntingtin Compromises Mitochondrial Function"

R01 HL066015 7/1/01–6/30/05
National Institutes of Health, NHLBI
PI: William Holman MD. My Role: Co-investigator (30%)
"Ischemia-Reperfusion Injury in Cardiac Surgery."

FUNDING

C. FELLOWSHIPS & OTHER AWARDS TO MENTEES

2007 Lindsay S. Burwell (Graduate Student). Elon Huntington Hooker Fellowship, 1 yr.
2008 Andrew P. Wojtovich, American Heart Association Pre-Doctoral Fellowship, 2 yrs.
2011 Andrew P. Wojtovich, American Heart Association Post-Doctoral Fellowship, 2 yrs.
2013 Rebecca Parodi-Rullan (graduate student w. Sabzali Javadov, Univ. Puerto Rico). SFRBM

Mini-Fellowship.

2014 Marcin Karcz MD. Foundation for Anesthesia Education and Research (FAER) Research Fellowship, 1 yr.

2017 Jimmy Zhang, American Heart Association Pre-Doctoral Fellowship, 2 yrs.
Jimmy Zhang, NIH NRSA F30 Pre-Doctoral Award (AHA Relinquished), 2 yrs.

2019 Chaitanya Kulkarni, PhD. American Heart Association Post-Doctoral Fellowship, 2 yrs.

2019 Alex Milliken, 1 yr. position on Biochemistry T32 training grant.

2021 Alex Milliken. American Heart Association Pre-Doctoral Fellowship, 2 yrs.

2024 Rahiim Lake, 1 yr. position on Biochemistry T32 training grant.

GRANT REVIEW

2004 Ad-Hoc, NIH Program Project Review Committee, NHLBI

2005 NIH (NIDDK) Special Emphasis Panel for RFA "Mitochondrial oxidative stress in diabetes and obesity"
Norwegian Foundation.

2006 US National Science Foundation.
Singaporean Science Foundation.

2007 Ad Hoc Member, NIH Program Project Review Committee, NIAAA
Wellcome Trust (UK)
Medical Research Council (UK)
NIH (NIDDK) Special Emphasis Panel for RFA "Biomarker development for diabetic complications".
Ad Hoc, Myocardial Ischemia & Metabolism (MIM) study section, NHLBI.
Standing Member, Grant Committee, United Mitochondrial Disease Foundation (UMDF)

2008 NIH (NIAAA) Special Emphasis Panel for RFA "Mitochondrial dysfunction in alcoholic liver disease".
Ad-Hoc, NIH study section for Loan Repayment Program, Clinical & Pediatric Research.
Catalan Agency for Health Technology Assessment and Research (CAHTA)
Erwin Schrodinger Program, Austrian Science Fund (FWF).
Wellcome Trust (UK)
Ad-Hoc, Myocardial Ischemia & Metabolism (MIM) study section, NHLBI.
Standing Member, Grant Committee, United Mitochondrial Disease Foundation (UMDF)

2009 Mail review of federal stimulus package RC-1 challenge grants, NIH (NHLBI).
Ad-Hoc, Myocardial Ischemia & Metabolism (MIM) study section, NHLBI.
Standing Member, Grant Committee, United Mitochondrial Disease Foundation (UMDF)

2010 Reviewer, National Science Foundation
Ad-Hoc, NIH Program Project Review Committee, NHLBI
(twice) AHA National Study Section (Cardiac Biology)
Wellcome Trust (UK)
Standing Member, Grant Committee, United Mitochondrial Disease Foundation (UMDF)

2011 Ad-Hoc, NHLBI Board of Scientific Counsellors (BSC) for intramural review.
NIH (NIEHS) Special Emphasis Panel for RFA "Biomarkers of environmentally induced mitochondrial dysfunction"
Standing Member, Grant Committee, United Mitochondrial Disease Foundation (UMDF)

2012 AHA National Study Section (Cardiac Biology)
Standing Member, NIH Myocardial Ischemia & Metabolism (MIM) study section.

2013 AHA National Study Section (Cardiac Biology)
Standing Member, NIH Myocardial Ischemia & Metabolism (MIM) study section.
2014 United Mitochondrial Disease Foundation (UMDF), Co-Chair
Standing Member, NIH Myocardial Ischemia & Metabolism (MIM) study section.
2015 United Mitochondrial Disease Foundation (UMDF), Co-Chair
Standing Member, NIH Myocardial Ischemia & Metabolism (MIM) study section.
2016 Standing Member, NIH Myocardial Ischemia & Metabolism (MIM) study section.
United Mitochondrial Disease Foundation (UMDF), Chair
Reviewer, NIH Special Emphasis Panel (CVRS Member Conflict)
Reviewer, AHA Collaborative Science Awards.
2017 United Mitochondrial Disease Foundation (UMDF), Chair
Reviewer, Nora Eccles Treadwell Foundation for Cardiovascular Research.
2018 Ad Hoc Reviewer, NIH Myocardial Ischemia & Metabolism (MIM) study section (2x).
AHA fellowships grant review (Molecular Signaling & Cell Transport Committee).
NIH CSR anonymization study grant reviewer
2019 Reviewer, NIH Special Emphasis Panel (CVRS Member Conflict).
Ad Hoc Reviewer, NIH Myocardial Ischemia & Metabolism (MIM) study section
2020 Reviewer, NIH Special Emphasis Panel (CVRS Member Conflict).
External site reviewer, NHLBI Intramural Research Program.
Ad-Hoc Reviewer, NIH Myocardial Ischemia & Metabolism (MIM) study section
2021 Reviewer, Heart Research UK (HRUK).
Ad-Hoc Reviewer, NIH Director's Early Independence Award program (DP5)
2022 External site reviewer, NHLBI Intramural Research Program.
Reviewer, AHA Collaborative Science Applications.
2023 Reviewer, British Heart Foundation Research Awards
Reviewer, American Heart Association Collaborative Science Awards (CSA)
2024 Reviewer, NIH Special Emphasis Panel (CVRS Member Conflict).
Reviewer, UAB Diabetes Center starter grants program.
Reviewer, NIH (NIDDK) U01 Grants.
Reviewer, (NHLBI) Small Business – SBIR/STTR Program.

PUBLICATIONS

A. PEER-REVIEWED, ORIGINAL SCIENTIFIC PAPERS (chronological order)

1. **Brookes PS**, Rolfe DFS, Brand MD. (1997) The proton permeability of liposomes made from mitochondrial inner membrane phospholipids: comparison with intact mitochondria. *J. Memb. Biol.* **155:**167-174
2. **Brookes PS**, Hulbert AJ, Brand MD. (1997) The proton permeability of liposomes made from mitochondrial inner membrane phospholipids: no effect of fatty acid composition. *Biochim. Biophys. Acta* **1330:**157-164
3. **Brookes PS**, Buckingham JA, Tenreiro AM, Hulbert AJ, Brand MD. (1998) The proton permeability of the inner membrane of liver mitochondria from exothermic and endothermic vertebrates and from obese rats: correlations with standard metabolic rate and phospholipid fatty acid composition. *Comp. Biochem. Physiol.* **119B:**325-334
4. **Brookes PS**, Land JM, Clark JB, Heales SJR. (1997) Stimulation of glyceraldehyde-3-phosphate dehydrogenase by oxyhemoglobin. *FEBS Lett.* **416:**90-92
5. **Brookes PS**, Land JM, Clark JB, Heales SJR. (1998) Peroxynitrite and brain mitochondria: evidence for increased proton leak. *J. Neurochem.* **70:**2195-2202

6. Changani, KK, Bell JD, Brooks KJ, Fuller BJ, Taylor-Robinson SD, Davidson BR, **Brookes PS**, Bates TE. (1998) Depression of liver mitochondrial complex II-linked respiration following cooling: beneficial effects of using a prostacyclin analogue during hypothermia. *Cryo-Letters* **19:**71-78

7. **Brookes PS**, Bolanos JP, Heales SJR. (1999) The assumption that nitric oxide inhibits mitochondrial ATP synthesis is correct. *FEBS Lett.* **446:**261-263

8. **Brookes PS**, Padilla-Salinas E, Darley-Usmar K, Eiserich JP, Freeman BA, Darley-Usmar VM, Anderson PG. (2000) Concentration dependent effects of nitric oxide on mitochondrial permeability transition and cytochrome *c* release. *J. Biol. Chem.* **275:**20474-20479

9. **Brookes PS**, Zhang J, Dai L, Zhou F, Parks DA, Darley-Usmar VM, Anderson PG. (2001) Increased sensitivity of mitochondrial respiration to inhibition by nitric oxide in cardiac hypertrophy. *J. Mol. Cell. Cardiol.* **33:**69-82

10. Shiva S, **Brookes PS**, Patel RP, Anderson PG, Darley-Usmar VM. (2001) Nitric oxide partitioning into mitochondrial membranes and the control of respiration at cytochrome *c* oxidase. *Proc. Natl. Acad. Sci. USA* **98:**7212-7217

11. Dai L, **Brookes PS**, Darley-Usmar VM, Anderson PG. (2001) Bioenergetics in cardiac hypertrophy: mitochondrial respiration as a pathological target of nitric oxide. *Am. J. Physiol*. **281:**H2261-2269

12. **Brookes PS**, Baggot JE. (2002) Oxidation of 10-formyl-tetrahydrofolate by complex IV of rat mitochondria. *Biochemistry.* **41:**5633-5636

13. Lin T-K, Hughes G, Muratovska A, Blaikie FH, **Brookes PS**, Darley-Usmar VM, Smith RAJ, Murphy MP. (2002) Specific modification of mitochondrial protein thiols in response to oxidative stress: a proteomics approach. *J. Biol. Chem.* **277:**17048-17056

14. **Brookes PS**, Digerness SB, Parks DA, Darley-Usmar VM. (2002) Mitochondrial function in response to cardiac ischemia-reperfusion after oral treatment with quercetin. *Free Rad. Biol. Med.* **32:**1220-1228

15. **Brookes PS**, Pinner AL, Ramachandran A, Coward L, Barnes S, Kim H, Darley-Usmar VM. (2002) High-throughput 2D blue-native electrophoresis, a tool for functional proteomics of mitochondria and cell-signaling complexes. *Proteomics.* **2:**969-977

16. Barone MC, Darley-Usmar VM, **Brookes PS**. (2003) Reversible inhibition of cytochrome *c* oxidase by peroxynitrite proceeds through ascorbate-dependent generation of nitric oxide. *J. Biol. Chem.* **278:**27520-27524

17. Venkatraman A, Shiva S, Davis AJ, Bailey SM, **Brookes PS**, Darley-Usmar VM. (2003) Chronic alcohol consumption increases the sensitivity of rat liver mitochondrial respiration to inhibition by nitric oxide. *Hepatology* **38:**141-147

18. **Brookes PS**, Kraus DW, Shiva S, Doeller JE, Barone MC, Patel RP, Lancaster JR, Darley-Usmar VM. (2003) Control of mitochondrial respiration by $NO^{\bullet}$, effects of low oxygen & respiratory state. *J. Biol. Chem.* **278:**31603-31609

19. **Brookes PS**, Darley-Usmar VM. (2004) Role of calcium and superoxide dismutase in sensitizing mitochondria to peroxynitrite-induced permeability transition. *Am. J. Physiol.* **286:**H39-H46

20. Digerness SB, **Brookes PS,** Goldberg SP, Katholi CR, Holman WL. (2003) Modulation of mitochondrial adenosine triphosphate-sensitive potassium channels and sodium-hydrogen exchange provide additive protection from severe ischemia-reperfusion injury. *J. Thorac. Cardiovasc. Surg.* **125:**863-871

21. Davies JE, Digerness SB, Goldberg SP, Killingsworth CR, Katholi CR, **Brookes PS,** Holman WL. (2003) Intra-myocyte ion homeostasis during ischemia-reperfusion injury: effects of pharmacologic preconditioning and controlled reperfusion. *Ann. Thorac. Surg.* **76:**1252-1258
22. Shiva S, Crawford JH, Ramachandran A, Ceaser EK, Hillson T, **Brookes PS**, Patel R, Darley-Usmar VM. (2004) Mechanisms of the interaction of nitroxyl with mitochondria. *Biochem. J.* **379:**357-366
23. Tompkins AJ, Burwell LS, Digerness SB, Holman WL, **Brookes PS**. (2005) Mitochondrial dysfunction in cardiac ischemia-reperfusion injury: ROS from complex I, without inhibition*. Biochim. Biophys. Acta.* **1762:**223-231
24. Brand MD, Pakay JL, Ocloo A, Kokoszka J, Wallace DC, **Brookes PS**, Cornwall EJ. (2005) The basal proton conductance of mitochondria depends on adenine nucleotide translocase content. *Biochem J.* **392:**353-362
25. Itoh S, Lemay S, Osawa M, Che W, Berdirian A, Tompkins A, **Brookes PS**, Yan C, Abe J-I. (2005) Mitochondrial Dok-4 recruits Src kinase and regulates mitochondria-derived reactive oxygen species (ROS) and subsequent NF-kB activation in endothelial cells. *J. Biol. Chem.* **280:**26383-26396
26. Burwell LS, Nadtochiy SM, Tompkins AJ, Young S, **Brookes PS**. (2006) Direct evidence for S-nitrosation of mitochondrial complex I. *Biochem. J.* **394:**627-634
27. Nadtochiy SM, Tompkins AJ, **Brookes PS**. (2006) Different mechanisms of mitochondrial proton leak in ischemia-reperfusion injury and preconditioning: implications for cardioprotection and pathology. *Biochem. J.* **395:**611-618
28. Hoffman D, Salter JD, **Brookes PS**. (2007) The response of mitochondrial reactive oxygen species generation to steady-state oxygen tension: implications for hypoxic cell signaling. *Am. J. Physiol.* **292:**H101-108
29. Shiva S, Sack MN, Greer JJ, Duranski M, Ringwood LA, Burwell LS, Wang X, MacArthur PH, Shoja A, Raghavachari N, Calvert JW, **Brookes PS**, Lefer DJ, Gladwin MT. (2007) Nitrite augments tolerance to ischemia-reperfusion injury via the modulation of mitochondrial electron transfer. *J. Exp. Med.* **204:**2089-2102.
30. Nadtochiy SM, Burwell LS, Young SM, **Brookes PS**. (2007) S-nitroso-2-mercaptopropionyl glycine (SNO-MPG), a novel mitochondrial S-nitrosating agent with cardioprotective effects. *J. Mol. Cell. Cardiol*. **42:**812-825
31. **Brookes PS**, Morse K, Ray DM, Tompkins AJ, Young SM, Hilchey S, Salim S, Konopleva M, Andreeff M, Phipps R, Bernstein SH. (2007) The triterpenoid CDDO and its derivatives elicit human lymphoid cell apoptosis through a novel pathway involving the unregulated mitochondrial permeability transition pore. *Cancer Res.* **67:**1793-1802
32. Guijarro A, Suzuki S, Chen C, Kirchner H, Middleton FA, Nadtochiy SM, **Brookes PS**, Niijima A, Inui A Meguid MM. (2007) Characterization of weight loss and regain after Roux-en-Y gastric bypass in rats. *Am. J. Physiol*. **293:** R1474-R1489
33. Guijarro A, Osei-Hyiaman D, Harvey-White J, Kunos G, Suzuki S, Nadtochiy S, **Brookes PS**, Meguid MM. (2008) Sustained weight loss after Roux-en-Y gastric bypass is characterized by down regulation of endocannabinoids and mitochondrial function. *Ann. Surg.* **247:** 779-790
33. Wojtovich AP, **Brookes PS**. (2008) The endogenous mitochondrial complex II inhibitor malonate regulates mitochondrial ATP-sensitive potassium channels:

Implications for ischemic preconditioning. *Biochim. Biophys. Acta.* **1777:** 882-889

34. **Brookes PS**, Parker N, Buckingham JA, Vidal-Puig A, Halestrap AP, Gunter TE, Nicholls DG, Bernardi P, Lemasters JJ, Brand MD. (2008) UCPs: Unlikely Calcium Porters. *Nature Cell Biol.* **10:** 1235-1237
35. Wojtovich AP, Burwell LS, Sherman TA, Nehrke KW, **Brookes PS**. (2008) The *C. elegans* mitochondrial K_{ATP} channel: A potential target for preconditioning. B*iochem. Biophys. Res. Commun.* **376:** 625-628
36. Nadtochiy SM, Nauduri D, Shimanskaya TV, Sagach VF, **Brookes PS.** (2008) Purine release: a protective signaling mechanism of the mitochondrial permeability transition pore in ischemia. *Fiziol. Zh*. **54**: 5-14
37. Wojtovich AP, **Brookes PS**. (2009) The complex II inhibitor atpenin A5 protects against cardiac ischemia-reperfusion injury via activation of mitochondrial K_{ATP} channels. *Basic Res. Cardiol.* **104:** 121-129
38. Nadtochiy SM, Baker PR, Freeman BA, **Brookes PS**. (2009) Mitochondrial nitroalkene formation and mild uncoupling in ischemic preconditioning: implications for cardioprotection. *Cardiovasc Res.* **82:** 333-340
39. Schopfer FJ, Batthyany C, Baker PRS, Bonacci G, Cole MP, Rudolph V, Groeger AL, Rudolph TK, Nadtochiy SM, **Brookes PS**, Freeman BA (2009) Detection and quantification of protein adduction by electrophilic fatty acids: mitochondrial generation of fatty acid nitroalkene derivatives. *Free Radic. Biol. Med.* **46:** 1250-1259
40. Nadtochiy SM, Burwell LS, Ingraham CA, Pinkert CA, **Brookes PS** (2009) In vivo cardioprotection by S-nitroso-2-mercaptopropionyl glycine. *J. Mol. Cell. Cardiol.* **46:** 960-968
41. Hoffman DL, **Brookes PS**. (2009) Oxygen sensitivity of mitochondrial reactive oxygen species generation depends on metabolic conditions. *J. Biol. Chem.* **284:** 16236-16245
42. Ingraham CA, Burwell LS, Skalska J, **Brookes PS**, Howell RL, Sheu S-S, Pinkert CA. (2009) NDUFS4: Creation of a mouse model mimicking a complex I disorder. *Mitochondrion.* **9:** 204-210
43. Prime TA, Blaikie FH, Nadtochiy SM, James AM, Dahm CC, Vitturi D, Patel RP, Hiley CR, Abakumova I, Requejo R, Chouchani E, Hurd TR, Garvey J, Taylor CT, **Brookes PS**, Smith RAJ, Murphy MP. (2009) A mitochondria-targeted S-nitrosothiol reversibly modulates respiration, selectively nitrosates mitochondrial thiol proteins and protects against cardiac ischemia-reperfusion injury. *Proc. Natl. Acad. Sci. USA.* **106:** 10764-10769
44. Skalska J, **Brookes PS**, Nadtochiy SM, Hilchey SP, Jordan CT, Guzman ML, Maggirwar SB, Briehl MM, Bernstein SH. (2009) Modulation of cell surface protein free thiols: a potential novel mechanism of action of the sesquiterpene lactone parthenolide. *PLoS one.* **4:** e8115
45. Gohil VM, Sheth SA, Nilsson R, Wojtovich AP, Lee J-H, Chen W, Clish C, Ayata C, **Brookes PS**, Mootha VK. (2010) Discovery of Drugs that Shift Mitochondrial Respiration to Glycolysis. *Nature Biotech.* **28:** 249-55
46. Roser KS, Wojtovich AP, Brookes PS, Olson LP, Shojaie J, Parton RL and M. W. Anders (2010) Mitochondrial biotransformation of ω-(phenoxy)alkanoic acids, 3-(phenoxy)acrylic acids, and ω-(1-methyl-1h-imidazol-2-ylthio)alkanoic acids: a prodrug strategy for targeting cytoprotective antioxidants to mitochondria. *Bioorg.*

Med. Chem. **18:** 1441-1448

47. Wojtovich AP, Williams DW, Karcz MK, Lopes CB, Gray DA, Nehrke KW, **Brookes PS** (2010) A novel mitochondrial K_{ATP} channel assay. *Circ. Res.* **106:** 1190-1196.
48. Caito S, Rajendrasozhan S, Cook S, Chung S, Yao H, Friedman AE, **Brookes PS**, Rahman I. (2010) SIRT1 is a redox-densitive deacetylase that is post-translationally modified by oxidants and carbonyl stress. *FASEB J.* **24:** 3145-3159.
49. Chouchani ET, Hurd TR, Nadtochiy SM, **Brookes PS**, Fearnley IM, Lilley KS, Smith RA, Murphy MP (2010) Identification of S-nitrosated mitochondrial proteins by S-nitrosothiol difference in gel electrophoresis (SNO-DIGE): implications for the regulation of mitochondrial function by reversible S-nitrosation. *Biochem. J.* 2010 **430:** 49-59.
50. Nadtochiy SM, Redman E, Rahman I, **Brookes PS** (2010) Lysine Deacetylation in Ischemic Preconditioning: The Role of SIRT1. *Cardiovasc.* Res. **89:** 643-649.
52. Quelcioni BB, Wojtovich AP, Nadtochiy SM, Kowaltowski AJ, **Brookes PS**. (2010) Redox Regulation of the Mitochondrial K_{ATP} Channel in Cardioprotection. *Biochim. Biophys. Acta. Mol. Cell Res.* **1813:** 1309-1315.
53. Gunter TE, Gerstner B, Lester T, Wojtovich AP, Malecki J, Swarts SG, **Brookes PS**, Gavin CE, Gunter KK. (2010) An analysis of the effects of Mn^{2+} on oxidative phosphorylation in liver, brain, and heart mitochondria using state 3 oxidation rate assays. *Toxicol. Appl. Pharmacol.* **249:** 65-75.
54. Ding B, Gibbs PE, **Brookes PS**, Maines MD. (2011) The coordinated increased expression of biliverdin reductase and heme oxygenase-2 promotes cardiomyocyte survival: a reductase-based peptide counters β-adrenergic receptor ligand-mediated cardiac dysfunction. *FASEB J.* **25:** 301-313.
55. Wojtovich AP, Nehrke KW, **Brookes PS**. (2010) The mitochondrial complex II and ATP-sensitive potassium channel interaction: Quantitation of the channel in heart mitochondria. *Acta Biochim. Pol.* **57:** 431-434.
56. Shi X, Yan C, Nadtochiy SM, Abe JI, **Brookes PS**, Berk BC. (2011) p90 ribosomal S6 kinase regulates activity of the renin-angiotensin system: A pathogenic mechanism for ischemia-reperfusion injury. *J. Mol. Cell. Cardiol.* **51:** 272-275.
57. Liu S, Lee Y-F, Chou S-M S, Uno H, **Brookes PS**, Massett MP, Sheu S-S, Chen L-M, Chang C. (2011) Mice lacking TR4 nuclear receptor suffer mitochondrial myopathy with complex I assembly factor NDUFAF1 deficiency. *Mol. Endocrinol.* **25:** 1301-1310.
58. Nadtochiy SM, Yoa H, McBurney MW, Gu W, Guarente L, Rahman I, **Brookes PS.** (2011) SIRT1 mediated acute cardioprotection. *Am. J. Physiol.* **301:** H1506-H1512.
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B. REVIEW ARTICLES & EDITORIALS

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C. BOOK CHAPTERS

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PUBLICATIONS

D. MANUSCRIPTS IN-PROCESS

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PUBLICATIONS

E. PATENTS

US20100168198A1 Mitochondria-Targeted Antioxidant Prodrugs and Methods of Use.

US20090149540A1 Compositions & Methods for Attenuating Mitochondria-Mediated Cell Injury.

US20240166603A1 Method of Treating Cancer with Atpenin A5 Derivatives.

PUBLICATIONS

F. SELECTED CONFERENCE ABSTRACTS

PRESENTER'S NAME UNDERLINED **SELECTED FOR ORAL PRESENTATION

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2. **Brookes PS**, Hulbert AJ, Buckingham JA, Tenreiro, AM, Brand MD. (1998) Mitochondrial, but not liposomal, proton leak correlates with membrane fatty acid composition. In *E.B.E.C. Short Reports* **10:** Proceedings of the 10th European Bioenergetics Conference, Göteborg, Sweden. Elsevier/EBEC Press.
3. **Brookes PS**, Land JM, Clark JB, Heales SJ. (1998) Peroxynitrite increases brain mitochondrial proton leak. In *E.B.E.C. Short Reports* **10:** Proceedings of the 10th European Bioenergetics Conference, Goteborg, Sweden. Elsevier/EBEC Press.
4. **Brookes PS**, Land JM, Clark JB, Heales SJ. (1998) Peroxynitrite causes proton leak in brain mitochondria. *Biochem Soc Trans.* **26:**S332
5. **Brookes PS**, Haley J, Cutler P, Camilleri P, Land JM, Clark JB, Heales SJ. (1998) Stimulation of glyceraldehyde-3-phosphate dehydrogenase by oxyhemoglobin. *Biochem Soc Trans.* **26:**S246
6. **Brookes PS.** (1998) Mitochondrial proton leak and superoxide generation: an hypothesis. *Biochem Soc Trans.* **26:**S331
7. **Brookes PS**, Padilla-Salinas E, Anderson PG, Darley-Usmar VM. (1999) NO inhibits cytochrome c release from isolated mitochondria: implications for apoptosis. *Free Rad Biol. Med.* **27 Sup:**S112, #347
8. Darley-Usmar VM, **Brookes PS**, Beckman JS, Anderson PG. (1999) The damaging and paradoxical effects of Cu/Zn superoxide dismutase on the peroxynitrite induced mitochondrial permeability transition. *Free Rad. Biol. Med.* **27 Sup:**S74 #211
9. **Brookes PS**, Darley-Usmar VM, Anderson PG. (2000) Nitric oxide and mitochondrial dysfunction in cardiac hypertrophy. *J. Mol. Cell. Cardiol.* **32#5:**A65
10. **Brookes PS**, Anderson PG, Darley-Usmar VM. (2000) How does nitric oxide control mitochondrial respiration? *Free Rad. Biol. Med.* **29 Sup:**S67
11. Ceasar EK, **Brookes PS**, Anderson PG, Murphy MP, Darley-Usmar VM. (2000) Mitochondrial protein thiols and permeability transition: effects of nitric oxide. *Free Rad. Biol. Med.* **29 Sup:**S90
12. Shiva S, **Brookes PS**, Patel RP, Darley-Usmar VM. (2000) Mitochondrial consumption of NO: implications for the inhibition of mitochondrial respiration. *Free Rad. Biol. Med.* **29 Sup:**S76
13. Dai L, **Brookes PS**, Darley-Usmar VM, Anderson PG. (2001) Nitric oxide and impaired energy metabolism in cardiac hypertrophy. *Circulation* **104 Sup:**#911

14. Pinner AL, **Brookes PS**, Darley-Usmar VM. (2001) 2D Blue-native electrophoresis: the key to mitochondrial proteomics. *Free Rad. Biol. Med.* **31 Sup:**S146
15. Ramachandran A, Xu J, Moellering D, Shiva S, **Brookes PS**, Darley-Usmar VM. (2001) Effects of inhibition of mitochondrial protein synthesis on nitric oxide dependent apoptosis. *Free Rad. Biol. Med.* **31 Sup:**S106

16. **Brookes PS, Pinner AL, Darley-Usmar VM. (2001) 2D Blue-native proteomics to probe mitochondrial oxidative stress. *Free Rad. Biol. Med.* **31 Sup:**S93

17. Akaike T, Shiva S, Patel RP, **Brookes PS**, Darley-Usmar VM. (2001) Glutathione nitroso-sulfoxide: a potential product of glutathione and peroxynitrite. *Free Rad. Biol. Med.* **31 Sup:**S76
18. Shiva S, **Brookes PS**, Kraus DW, Patel RP, Darley-Usmar, VM. (2001) Mitochondrial sensitivity to nitric oxide is dependent on respiratory state. *Free Rad. Biol. Med.* **31 Sup:**S73
19. Dai L, **Brookes PS**, Darley-Usmar VM, Anderson PG. (2001) Nitric-oxide-mediated bioenergetic defect in cardiac hypertrophy. *Free Rad. Biol. Med.* **31 Sup:**S68
20. Kevil CG, **Brookes PS**, Bullard DC, Patel RP. (2001) Regulation of endothelial cell redox status by ICAM-1: identification of a novel pathway governing endothelial cell reactivity. *Free Rad. Biol. Med.* **31 Sup:**S47

21. **Brookes PS, Baggott JE. (2002) 10-formyl-tetrahydrofolate (10-f-THF) supports mitochondrial respiration. *Experimental Biology.* New Orleans LA.

22. **Brookes PS**, Pinner AL, Darley-Usmar VM. (2002) A proteomics approach to study tyrosine nitration of mitochondrial complex I during cardiac ischemia-reperfusion. *Keystone Symposium on Mitochondrial Pathogenesis*. Copper Mountain, CO, April 2002.
23. **Brookes PS**, Pinner AL, Darley-Usmar VM. (2002) 3D proteomic methods to identify molecular lesions within subunits of mitochondrial complex I. *Free Red. Biol. Med*. **33 Sup:**S400
24. Landar A, Levonen A-L, Shiva S, **Brookes PS**, Darley-Usmar VM. (2002) A proteomics approach to the identification of mitochondrial proteins modified by oxidized lipids. *Free Red. Biol. Med*. **33 Sup:** S387
25. Fenster C, Darley-Usmar VM, Landar A, **Brookes PS**, Hunter G, Weinsier RL, Patel RP. (2002) Associations of weight loss and race with plasma NO_3/NO_2 and 3-nitrotyrosine. *Free Red. Biol. Med*. **33 Sup:** S366
26. Shiva S, **Brookes PS**, Kraus DW, Doeller JE, Barone MC, Patel RP, Darley-Usmar VM. (2002) The potency of nitric oxide as a mitochondrial inhibitor is dependent on respiratory state. *Free Red. Biol. Med*. **33 Sup:**S364

27. **Brookes PS. (2003) Superoxide, nitric oxide, and their interactions with mitochondrial uncoupling. *Free Rad. Biol. Med.* **35 Sup:**S9

28. **Brookes PS. (2004) Mitochondria and $NO^{\bullet}$ - new insight from open flow respirometry and ischemic injury. *Comp. Biochem. Physiol. Part B.* **139,** 137-149, S8.

29. Tompkins AJ, Burwell LS, **Brookes PS**. (2004) Complex I in cardiac ischemia reperfusion: thiol damage, more ROS, but no enzymatic inhibition. Joint meeting of the Mitochondrial Research Society and the United Mitochondrial Disease Foundation, Pittsburgh PA.
30. Tompkins AJ, Burwell LS, **Brookes PS**. (2004) Mitochondrial dysfunction in ischemia-reperfusion injury: a role for ROS generation by complex I without inhiibition. *Free*

Rad. Biol. Med. **37 Sup:**S220

31. Burwell LS, Tompkins AJ, **Brookes PS**. (2004) S-nitrosothiol detection in the mitochondrial proteome: a more precise representation. *Free. Rad. Biol. Med.* **37 Sup:**S116

32. **Brookes PS. (2005) Mitochondria at low oxygen. 49th Annual meeting of the Biophysical Society. Long Beach CA.

33. **Brookes PS, Robotham JL. (2005) Mitochondrial H^+ Leak in Cardiac Ischemia-Reperfusion and Preconditioning. Association of University Anesthesiologists, 52nd Annual Meeting, Baltimore MD.

34. **Brookes PS. (2005) ROS generation by isolated mitochondria does not increase at low oxygen. Joint meeting of the Mitochondrial Research Society and the United Mitochondrial Disease Foundation, St. Louis MO.

35. **Brookes PS. (2005) Mitochondrial function in cardiac ischemia-reperfusion injury and ischemic preconditioning. Mitochondrial Physiology meeting, Schröeken, Austria.

36. Yang S-R, Bauter M, **Brookes P**, Rahman I. (2005) Cigarette smoke induces post-translational modifications of deacetylase proteins and inflammatory cytokines in macrophages and rat lungs. *Free. Rad. Biol. Med.* **39 Sup:** S56

38. Hoffman DL, **Brookes PS**. (2005) ROS generated by mitochondria at lot O_2 tensions. *Free. Rad. Biol. Med.* **39 Sup:**S25

39. Nadtochiy SM, Burwell LS, Young S, **Brookes PS**. (2005) Mitochondrial H^+ leak in cardiac preconditioning and ischemic injury: direct mechanisms and upstream signals. *Free. Rad. Biol. Med.* **39 Sup:**S139

40. Burwell LS, Nadtochiy SM, Young S, **Brookes PS** (2005) Complex I S-nitrosation and protection against ischemic injury. *Free. Rad. Biol. Med.* **39 Sup:**S135

41. **Brookes PS. (2006) Mitochondria and $NO^{\bullet}$ in cardiac ischemia-reperfusion injury and preconditioning. *Free Rad. Res.* **40 Sup1:**S55

42. **Brookes PS, Burwell LS, Nadtochiy SM. (2006) Nitric Oxide as a critical regulator of mitochondrial function in hypoxia/ischemia. *Keystone Symposium - Metabolomics: from Bioenergetics of Pathogenesis*. Snowbird, UT.

43. **Brookes PS**, Oksea A, Hoffman DL (2006) Potential role of RISP phosphorylation in the regulation of hypoxic ROS generation. *Free Rad. Biol. Med.* **41 Sup:**S37

44. Shiva S, Sack MN, Duranski M, Ringwood LA, Wang X, Raghavachari N, MacArthur P, Burwell LS, **Brookes PS**, Lefer DJ, Gladwin MT. (2006) Nitrite mediates both classical and long term preconditioning from ischemia/reperfusion injury at the mitochondrial level. *Free Rad. Biol. Med.* **41 Sup:**S62

45. **Brookes PS, Nadtochiy SM, Baker PRS, Freeman BA (2006) Nitrated lipids stimulate mitochondrial proton leak: Implications for ischemic preconditioning. *Free Rad. Biol. Med.* **41 Sup:**S138

46. Burwell LS, Nadtochiy SM, **Brookes PS. (2006) Enhancement of mitochondrial S-nitrosation and cardioprotection during ischemia reperfusion injury by S-nitroso-2-mercaptopropionyl glycine (SNO-MPG). *Free Rad. Biol. Med.* **41 Sup:**S146

47. **Brookes PS**, Wojtovich AP (2006) Complex II regulation by malonate formation: a potential mechanism of cardioprotection. *Free Rad. Biol. Med.* **41 Sup:**S153

48. Burwell LS, **Brookes PS**. (2007) The Cardioprotective Effect of Mitochondrial S-nitrosation in Ischemia Reperfusion Injury. *2nd International meeting on the Role of*

Nitrite in Physiology, Pathophysiology, and Therapeutics. NIH, Bethesda MD.

49. Nadtochiy SM, **Brookes PS. (2007) Nitro-alkenes and mitochondrial uncoupling: a novel cardioprotective pathway. Joint meeting of the Mitochondrial Physiology Society & the 64th Biochemical Society Harden Conference. Ambleside, Lake District, UK.

50. Burwell LS, **Brookes PS**. (2007) Novel insights into mitochondrial function during the initial moments of reperfusion following ischemia: effects of nitric oxide. *Free Rad. Biol. Med.* **43 Sup:**S76

51. Wojtovich AP, **Brookes PS**. (2007) The endogenous mitochondrial complex II inhibitor malonate regulates mito-K^+_{ATP} channels: importance for ischemic preconditioning. *Free Rad. Biol. Med.* **43 Sup:**S81

52. Hoffman DL, **Brookes PS**. (2007) Differences in O_2 dependence of ROS generation, for sites within the respiratory chain. *Free Rad. Biol. Med.* **43 Sup:**S151

53. Nadtochiy SM, **Brookes PS. (2007) Post-translational modification of mitochondrial proteins by nitro-alkenes as a potential mechanism for cardioprotection. *Free Rad. Biol. Med.* **43 Sup:**S156

54. **Brookes PS. (2008) Ischemic preconditioning invokes multiple mechanisms of nitric oxide and reactive oxygen signaling at the mitochondrial level. *Biochim. Biophys. Acta* **1777 S1:** S58, #218.

55. **Brookes PS. (2008) Cytoprotection and mitochondrial S-nitrosation in cardiac ischemia-reperfusion injury. Proceedings of the 13th Annual Meeting of the Southeastern Pharmacological Society (SEPS), Charleston SC.

56. **Brookes PS.** (2008) Ischemic preconditioning invokes multiple mechanisms of nitric oxide and reactive oxygen signaling at the mitochondrial level. Proceedings of the 15th European Bioenergetics Conference (EBEC), Dublin, Ireland.

57. Hoffman DL, **Brookes PS**. (2008) Modeling mitochondrial responses to oxygen tension. Gordon Research Conference (GRC) on Macromolecular Organization & Cell Function, Oxford, UK.

58. Nadtochiy SM, **Brookes PS. (2009) Sirtuins and Cardioprotection. 7th Annual Scientific Sessions of the Society for Heart and Vascular Metabolism (SVHM). Padova, Italy.

59. Wojtovich AP, **Brookes PS**. (2009) Characterization of the mK_{ATP} channel: Evidence for a Kir, SUR and complex II composition. *Free Rad. Biol. Med.* **47 Sup:** S173

60. Nadtochiy SM, **Brookes PS** (2009) Post-translation modification of cytosolic and mitochondrial proteins via Lys (de)acetylation: potential implication of Sirtuins for ischemic preconditioning. *Free Rad. Biol. Med.* **47 Sup:** S173

61. Wojtovich AP, **Brookes PS** (2010) Mitochondrial K^+_{ATP} channels – novel assay and regulation by fluoxetine. Proceedings of the 16th European Bioenergetics Conference (EBEC), Warsaw, Poland.

62. **Brookes PS**. (2010) A High Throughput Screen for Molecules that Protect Against Ischemia-Reperfusion Injury. *Free Rad. Biol. Med.* **49 Sup:** S15

63. Nadtochiy SM, **Brookes PS**. (2010) Nitro-alkenes confer cardioprotection nand modify Cys159 of Adenine Nucleotide Translocase in perfused Heart. *Free Rad. Biol. Med.* **49 Sup:** S27

64. Guo S, Olm-Shipman A, Redman EK, Urciuoli WR, **Brookes PS.** (2011). A High Throughput Screen for Molecules that Protect Against Ischemia-Reperfusion Injury.

NHLBI 2011 Mitochondrial Symposium.

65. Nadtochiy, SM, **Brookes PS**. (2013) Mitochondrially targeted nitro-linoleate, a novel cardioprotective agent. American Heart Association, Basic Cardiovascular Sciences 2013 Meeting, Las Vegas NV.
66. Wojtovich AP, Smith CO, Nadtochiy SM, Urciuoli WR, Xia X-M, Jonas E, Lingle CJ, Nehrke KW, **Brookes PS**. (2014) Anesthetic Preconditioning and Mitochondrial Slo K+ channel Activity Require Slo2.1. American Heart Association, Basic Cardiovascular Sciences 2014 Meeting, Las Vegas NV. *AHA Travel Award Recipient
67. Nadtochiy SM, Urciuoli WR, **Brookes PS**, Porter GA Jr. (2014) Mitochondrial Protein Acetylation in Aged Hearts in the Context of Ischemia-Reperfusion Injury. American Heart Association, Basic Cardiovascular Sciences 2014 Meeting, Las Vegas NV.
68. Acuna DE, **Brookes PS**, Kording KP. (2014) Automatic detection of figure element reuse in biological science articles. Science of Team Science Conference. Austin TX.
69. **Brookes PS**. (2015) Metabolomics of the preconditioned heart. 2015 Keystone Symposium on cardiac metabolism. Santa Fe NM.
70. **Brookes PS**. (2015) High Throughput Screening for Cardioprotection. FASEB Science Research Conference on Mitochondrial Biogenesis and Dynamics. Palm Beach FL.
71. **Brookes PS.** (2017) Acid pH and Metablic Remodeling in Ischemia. 2017 Keystone Symposium on Mitochondrial Communication. Taos NM.
72. **Brookes PS.** (2017) Reverse Electron Transfer in Ischemia/Reperfusion: Benefit or Detriment? Biophysical Society Annual Meeting. New Orleans LA.

73. Nadtochiy SM, **Brookes PS (2017) Stimulation of glycolysis accounts for the cardioprotective effects of the NAD^+ precursor nicotinamide mononucleotide (NMN). TriMAD – Translational Research in Mitochondria Aging and Disease, Pittsburgh PA.

74. Nadtochiy SM, **Brookes PS (2017) Stimulation of glycolysis accounts for the cardioprotective effects of the NAD^+ precursor nicotinamide mononucleotide (NMN). SFRBM Annual Meeting, Baltimore MD.

75. Nadtochiy SM, **Brookes PS** (2018) Succinate and Acidosis in Cardiac Ischemia. Society for Heart & Vascular Metabolism annual meeting. Charleston SC.
76. Kulkarni CA, Milliken AS, **Brookes PS** (2019) Role of acidic pH in linking SIRT1 and cardioprotective metabolism. American Heart Association Basic Cardiovascular Sciences meeting. Boston MA.
77. Kulkarni CA, Milliken AS, **Brookes PS** (2019) Acidosis and metabolic remodeling in cardioprotection. NHLBI Mitochondrial Biology Meeting, Bethesda MD.
78. Kulkarni CA, Nadtochiy SM, **Brookes PS** (2022) Methylglyoxal and Cardiac Ischemia-Reperfusion Injury. Cardiac Metabolism Keystone Meeting, Breckenridge CO.
79. Tabata Fukushima C, Dancil I, Clary H, Shah N, **Brookes PS**. (2023) Relative importance of reactive oxygen species from reverse electron transfer at mitochondrial complex I in early reperfusion injury. AHA BCVS Meeting, Boston MA.

JOURNAL DUTIES

A. MANUSCRIPTS REVIEWED (during past 5 years)

Mitochondrion	*J. Physiol*	*J. Gen Physiol.*
Circ. Res.	*Circulation*	*Cell*
J. Mol. Cell. Cardiol.	*Chem. Res. Toxicol.*	*Nature Cell Biol.*
Anesthesiology	*Nutrition*	*Free Rad. Biol. Med.*

PLoS One	*Biochemistry*	*Nature Comms.*
Biochim. Biophys. Acta	*Nature Med.*	*Biochem. Pharmacol.*
AJP Cell	*Nature*	*Brit. J. Pharmacol.*
Biochem. J.	*Cardiovasc. Res.*	*AJP Heart/Circ.*
AJP Integr/Comp	*J. Biol. Chem.*	*Antiox. Redox Signal.*
Cell Metabolism	*Cell Reports*	*Redox Biol.*

JOURNAL DUTIES

B. EDITORIAL BOARD MEMBERSHIPS

Free Radical Biology & Medicine, Editorial Board, 2007 – 2020
Am. J. Physiol. Heart Circ. Physiol., Editorial Board, 2011 – 2020
Chemico-Biological Interactions, Editorial Board, 2008 – 2020
Biochemical Journal, Editorial Board, 2007 –
Journal of Molecular & Cellular Cardiology, Editorial Board 2008 –
PeerJ, Founding Editorial Board member, 2012 –
Essays in Biochemistry, Editorial Oversight Committee, 2014 – 2024
Mitochondrion, Reviewing Editor, 2015 – 2024
Redox Biology, Editorial Board, 2023 –

PRESENTATIONS

A. INVITED LECTURES AT OUTSIDE INSTITUTIONS

1999 "Mitochondria and nitric oxide in cardiac hypertrophy". Dunn Human Nutrition Unit, Cambridge, UK.

2003 "Mitochondria, nitric oxide & superoxide: an unholy trinity". Dorothy Davis Heart & Lung Center, Ohio State University, Columbus OH.

"Mitochondria, nitric oxide & superoxide: an unholy trinity". Department of Physiology, LSU Health Sciences Center, Shreveport LA.

"Superoxide, nitric oxide and proton leak: a mitochondrial Bermuda triangle". Departments of Anesthesiology & Pharmacology / Physiology, University of Rochester Medical Center, Rochester NY.

2004 "Mitochondria at low oxygen". Free Radical Seminar Series, Medical College of Wisconsin, Milwaukee WI.

"Cardiac ischemia-reperfusion: from preconditioning to mito-SNO-proteomics". Proteomics Group, UCLA, Los Angeles CA.

2005 "Mitochondria, more than just ATP cows". Department of Biology, Niagara University at Buffalo, NY.

"Mitochondrial S-nitrosation in Ischemia-Reperfusion Injury & Ischemic Preconditioning". Department of Anesthesiology, University of Maryland, Baltimore MD.

2006 "Mitochondrial shutdown as a cardioprotective pathway". Cardiovascular Research Symposium, University of Alabama at Birmingham, Birmingham AL.

"Convergent cardioprotection via mitochondria". Department of Pharmacology & Toxicology, Medical College of Wisconsin, Milwaukee WI.

"Multiple Cardioprotective Roles of $NO^{\bullet}$ at the Mitochondrial Level". Institute of Molecular Cardiology, Johns Hopkins University, Baltimore MD.

2007 "Cardioprotection by Nitric Oxide: Novel Mitochondrial Mechanisms". Neonatology Grand Rounds, Children's Hospital of Philadelphia, Univ. of Pennsylvania, Philadelphia

PA.

"Mitochondrial Pathways of Ischemic Protection - Nitric Oxide as a Key Mediator". Buck Institute for Aging Research, Novato CA.

2008 "Biochemical Mechanisms of Cardioprotection at the Mitochondrial Level". University of Washington Department of Anesthesiology, Seattle WA.

"Mitochondria & Cardioprotection". Whitaker Institute of Cardiovascular Sciences, Boston University, Boston MA.

2009 "Nitrolipids, Atpenins & Cardioprotection". Department of Pharmacology, University of Pittsburgh, Pittsburgh PA.

"Cardioprotection: from red wine to Prozac". Institute of Molecular Cardiology, University of Louisville, KY.

2010 "Cardioprotection: A Pharmacological Approach". Institute for Environmental Medicine, University of Pennsylvania, Philadelphia PA.

"Mitochondria: At the Heart of Cardioprotection". Dept. of Biochemistry, SUNY Upstate Medical Center, Syracuse NY.

"Modulating Mitochondrial Metabolism as a Protective Strategy in Cardiac Ischemia". Seahorse Biosciences Webinar (www.seahorsebio.com)

"High Throughput Screening for Cardioprotection". Sanford Institute for Medical Research, Sioux Falls SD.

"Drug Development for Cardiac Ischemia – Insights from Nitric Oxide, Mitochondria and Redox Signaling". Department of Lung Biology, University of Vermont, Burlington VT.

2011 "Cardioprotective Drugs: Bottom-up vs. Top-down Approaches". Center for Immunology & Microbial Disease, Albany Medical College, Albany NY.

2012 "The role of SIRT1 and Nitro-Lipids in Cardioprotection". Dept. Pathology, Univ. Alabama at Birmingham, Birmingham AL.

"Role of Sirtuins in Ischemic Preconditioning". Oklahoma Medical Research Foundation, Oklahoma City OK.

"Potassium Channels, Cardiac Neurons and Cardioprotection". Dept. Physiology, Eastern Carolina University, Greenville NC.

"Using the Brain to Protect the Heart – Cardiac Neurons and Ischemic Injury". Hatter Institute for Cardiovascular Sciences, University College London, England.

2013 "Using the Brain to Protect the Heart" Dept. of Anesthesiology Research Seminar, Washington University, St. Louis MO.

"Identification of Mitochondrial KATP and BK Channels Involved in Cardioprotection". Cardiovascular Research Center, Temple University, Philadelphia PA.

2014 "Mitochondrial K^+ Channels Responsible for Anesthetic Preconditioning". Dept. of Anesthesiology, Mass. General Hospital, Harvard Medical School, Boston MA.

2015 "Mitochondrial K^+ channels, metabolomics, and cardioprotection". Dept. of Biochemistry, University of Louisville, Louisville KY.

"Mitochondrial Metabolomics in Cardiac Ischemia". Center for Cardiovascular Research, University of Illinois at Chicago, Chicago IL.

"High Throughput Screening for Cardioprotective Drugs with Mitochondrial Activity". Wilf Family Cardiovascular Research Institute, Albert Einstein College of Medicine of Yeshiva University, Bronx NY.

2016 "Cardioprotection: Metabolism, Ion Channels & Beyond". Comprehensive

Cardiovascular Center, University of Alabama at Birmingham.

"Cancer Metabolism & Cardioprotection". Department of Pharmacology, University of Colorado Denver.

"Acid pH and Metabolism in Heart Attack and Cancer". Biology Department, Nazareth College, Rochester NY.

"Leaking Acid from the Battery: Hypoxia and Promiscuous Metabolism". Department of Chemistry, Wells College, Aurora NY.

2017 "Cardiac and Cancer Metabolism". Department of Biological Sciences, LeMoyne University, Syracuse NY.

"2-Hydroxyglutarate: At the Intersection of Cardioprotection and Cancer Biology". Cardiovascular Center, Medical College of Wisconsin, Milwaukee WI.

2018 "Acidosis and Metabolic Signaling". Department of Biology, Colgate University, NY.

"Sirtuins & Acidosis in Cardiac Ischemia". Department of Physiology, University of Puerto Rico, San Jaun PR.

2019 "Acid in the (power)house: pH as a metabolic regulator in cardiac ischemia". NHLBI Intramural Research Program Seminar Series, NIH, Bethesda MD.

"Metabolism in Cardiac Ischemia". Dept. of Biology, Daemen College, Amherst NY.

2021 "Mitochondria & Methylglyoxal Metabolism". MitoCircle group, Thomas Jefferson University, Philadelphia PA (via Zoom).

"Suspected Image Manipulation and its Dire Consequences". Annual Ethics Lecture, University of Southern California (via Zoom).

"Methylglyoxal and Cardiac Ischemia". Cardiovascular Seminar Series. Queen Mary's University, London UK (via Zoom).

2022 "Methylgyoxal Metabolism & Cardiac Ischemia: Is Diabetes All Bad?" University of Pittsburgh, Vascular Biology Program (via Zoom).

"Succinate in Cardiac Ischemia". Daemen College Department of Biology, Buffalo NY.

"Succinate Metabolism in Heart Attack". St. John Fisher University, Rochester NY.

2023 "Scientific Image Manipulation and its Consequences". Wells College, Aurora NY.

2024 "Complex I Reversal in Heart Attack". Biochemistry, Michigan State University, East Lansing MI

"Two-Steps Forward, One Step Back – Reversal of Respiration in Ischemia/Hypoxia". Pharmacology, University of Pittsburgh Medical Center, Pittsburgh PA.

"Non-ATP Mechanisms of Glycolytic Cardioprotection". Tufts University Cardiovascular Research Institute. Boston MA.

PRESENTATIONS

B. INVITED PLENARY LECTURES AT INTERNATIONAL CONFERENCES

2002 "A proteomics approach to study tyrosine nitration of mitochondrial complex I during cardiac ischemia-reperfusion". Oxygen Club of California 2002 World Congress. Santa Barbara CA.

2003 "Superoxide, nitric oxide, and mitochondrial uncoupling". Society for Free Radical Biology and Medicine, 10th Annual Meeting, Seattle WA.

2004 "Mitochondria and NO$^{\bullet}$ - new insight from open flow respirometry and ischemic injury". Society for Experimental Biology meeting on NO in Comparative Biology. Capri, Italy.

2005 "Mitochondria in cardiac ischemia-reperfusion injury". Biophysical Society Annual Meeting (Bioenergetics Sub-group), Long Beach CA.

2006 "Mitochondria, S-nitrosothiols and cardiac ischemia". Gordon Conference on Oxygen Radicals. Ventura CA.

"Mitochondria: an end-point for $NO^{\bullet}$ signaling in ischemic preconditioning". Oxygen Club of California 2006 World Congress. Santa Barbara CA.

"Mitochondria: an end-point for $NO^{\bullet}$ signaling in ischemic preconditioning". Keystone Symposium – Metabolomics: from Bioenergetics to Pathogenesis. Snowbird UT.

"Mitochondria: an end-point for $NO^{\bullet}$ signaling in ischemic preconditioning". Joint meeting of the Mitochondrial Research Society and the United Mitochondrial Disease Foundation, Atlanta GA.

"Mitochondria: More Than Just ATP Cows". Society for Free Radical Biology & Medicine 13th Annual meeting, Denver CO.

"The Mitochondria/$NO^{\bullet}$ axis of Cardioprotection". Society for Free Radical Research, 13th International Congress, Davos, Switzerland.

2007 "$NO^{\bullet}$-mediated post-translational modifications to the mitochondrial proteome". NHLBI workshop on mitochondrial proteomics in cardiovascular disease. NIH, Bethesda MD.

2008 "Dysfunction is NO accident" in round-table session on "Mitochondrial Dysfunction in Multi Organ Failure". American Thoracic Society Annual meeting, Toronto, Canada

"Ischemic Preconditioning Invokes Multiple Mechanisms of Nitric Oxide and Reactive Oxygen Signaling at the Mitochondrial Level". 15th European Bioenergetics Conference (EBEC), Dublin, Ireland.

"Modeling Mitochondrial Responses to Oxygen Tension". Gordon Research Conference on Macromolecular Organization & Cell Function. Oxford, UK.

"Cytoprotection & Mitochondrial S-nitrosation". Southeastern Pharmacological Society (SEPS) Meeting, Charleston SC.

2009 "Mitochondrial Proteomics". 5th Annual US Human Proteome Organization (US-HUPO) Conference, San Diego CA.

"Sirtuins & Cardioprotection". Gordon Research Conference on Molecular & Cellular Bioenergetics. Andover NH.

"Sirtuins and Cardioprotection". 7th Annual meeting of the Society for Heart & Vascular Metabolism (SHVM). Padova, Italy.

2010 "Changing the Flux of ROS in Mitochondria" Gordon Conference on Oxygen Radicals. Ventura CA.

2011 "Mitochondrial Metabolism & Drug Development for IR Injury". Meeting of the British Society for Cardiovascular Research, London England.

"Redox Regulation of Mitochondrial Potassium Channels". Symposium on Metabolic Signaling & Cardioprotection. American Heart Association Scientific Sessions. Orlando FL.

2012 "Mitochondria in Ischemia-Reperfusion Injury". Symposium on Mitochondrial dynamics and function in cardiovascular disease. Experimental Biology 2012. San Diego CA.

"Regulation of cardioprotective mitochondrial K^+ channels". Gordon Research Conference on Cardiac Regulatory Mechanisms, Colby-Sawyer College, London NH.

"Mitochondrial targets for cardioprotective therapeutics". Society for Free Radical Research International (SFRRI) meeting, London England.

"Mitochondrial Redox Signaling". Society for Free Radical Biology & Medicine 19th Annual meeting, San Diego CA.

2013 "Mitochondrial BK Channels & Anesthetic Preconditioning". American Physiological Society Puerto Rico Chapter Annual Meeting. UPR, San Juan Puerto Rico.

2015 "Mitochondria – Critical Mediators of Cardioprotection". FASEB Conference on Mitochondrial Biogenesis and Dynamics in Health, Disease and Aging. West Palm Beach FL.

"Mitochondrial ROS Generation". 9th Mitochondrial Physiology (MiP) School, East Carolina University, Greenville NC.

"Mitochondrial Contributions to Ischemic Injury and Cardioprotection". American Physiological Society conference on Physiological Bioenergetics: From Bench to Bedside. Tampa, FL.

2016 "The Role of Pseudonyms & Snark on Post-Publication Peer Review". Impact or Perish: Innovating Misconduct in the Age of Metrics, UC Davis, Davis CA.

"Sirtuins and Mitochondrial Redox" Oxygen Radicals Gordon Conference, Ventura CA.

2017 "Reversing Electron Transport in Ischemia and Beyond". Biophysical Society Annual Meeting. New Orleans LA.

2018 "Mitochondria & Cardioprotection". Joint meeting of the Association of University Anesthesiologists (AUA) & the International Anesthesia Research Society (IARS). Chicago IL.

"Mitochondria and Acid pH in Cardioprotection". Society for Heart and Vascular Metabolism (SHVM) Annual Meeting. Charleston SC.

"Mitochondrial Complex II as a Therapeutic Target in Cardiac Ischemic Injury". Drug Discovery 2018, San Francisco CA.

2019 "Non-canonical Krebs' cycle metabolite signaling in cardiac ischemia". International Society for Heart Research world congress, Tianjin/Beijing China.

2021 "Science Fraud" Computational Research Integrity Conference (CRI-Conf), Syracuse NY (via Zoom).

"Mitochondria and Redox" SfRBM Annual Meeting (via Zoom).

2022 "Mitochondrial Metabolism in Cardiac Ischemia". Cardiac Metabolism Keystone Meeting, Breckenridge CO.

2024 "Misconduct Detection". UPenn Symposium on Research Integrity. Philadelphia PA.

PRESENTATIONS **C. SHORT CONFERENCE PRESENTATIONS, SELECTED FROM SUBMITTED ABSTRACTS**

1998 "Peroxynitrite causes proton leak in brain mitochondria." 666th meeting of The Biochemical Society, Sheffield, England.

2001 "2D Blue-native proteomics to probe mitochondrial oxidative stress." Oxygen Society 8th Annual Meeting, Research Triangle Park, Raleigh-Durham NC.

2002 "10-formyl-tetrahydrofolate (10-f-THF) supports mitochondrial respiration. Experimental Biology (ASNS). New Orleans LA.

2004 "Complex I in cardiac ischemia reperfusion: thiol damage, more ROS, but no enzymatic inhibition." Joint meeting of the Mitochondrial Research Society and the United Mitochondrial Disease Foundation, Pittsburgh PA.

2005 "Mitochondrial H^+ Leak in Cardiac Ischemia-Reperfusion and Preconditioning". Association of University Anesthesiologists, 52nd Annual Meeting, Baltimore MD.

"Mitochondrial ROS Generation does not Increase at Low Oxygen". Joint meeting of the

Mitochondrial Research Society and the United Mitochondrial Disease Foundation, St Louis MO.

"Mitochondrial function in cardiac ischemia-reperfusion injury and ischemic preconditioning". Mitochondrial Physiology meeting, Schröeken Austria.

2007 "Nitro-alkenes: Novel effectors of cardioprotection at the mitochondrial level". Joint meeting of the UK Biochemical Society & Mitochondrial Physiology. Ambleside, Lake District, United Kingdom.

2017 "Direct stimulation of glycolysis accounts for cellular metabolic benefits of the NAD+ precursor nicotinamide mononucleotide". Translational Research in Mitochondria, Aging & Disease (TriMAD) meeting, Pittsburgh PA.

"Stimulation of glycolysis accounts for the cardioprotective effects of the NAD^+ precursor nicotinamide mononucleotide (NMN)." SFRBM Annual Meeting, Baltimore MD.

PRESENTATIONS

D. INTRAMURAL SEMINARS

2001 "Mitochondrial uncoupling proteins: certainties & uncertainties" UAB Clinical Nutrition Center Seminar Series.

"Mitochondrial proteomics of cardiovascular disease". UAB Hypertension program seminar series.

2002 "Mitochondria: much more than ATP makers". UAB Advances in Molecular & Cellular Pathology seminar series

"Mitochondria: from proton leak to free radicals and back again". UAB Physiology & Biophysics seminar series.

"Concepts regarding UCPs, free radicals & metabolic rate" UAB Clinical Nutrition Center seminar series.

2003 "Mitochondria and $NO^\bullet$ - a lot more to learn". URMC Pharmacology & Physiology Seminar Program.

2004 "Cardiac ischemia-reperfusion: A microcosm of nitric oxide- mitochondrial interactions". URMC Center for Aging and Developmental Biology Seminar Series.

2005 "Cardiac ischemia-reperfusion & preconditioning: roles of mitochondria & nitric oxide". URMC Department of Anesthesiology, Grand Rounds.

2006 "The Mitochondria/Nitric Oxide Axis of Cardioprotection". URMC Department of Anesthesiology, Grand Rounds.

2007 "Nitro-fatty acids: a novel class of electrophilic signaling molecules with cardioprotective properties". URMC Biochemistry Graduate Student Cluster Annual Retreat, Casa Larga Vineyards, Victor NY.

"Nitric oxide mediated cardioprotection". URMC Cardiovascular Research Institute Seminar Series.

2008 "Mitochondria and Cardioprotection". URMC Department of Anesthesiology, Grand Rounds.

2009 Mitochondria, Hypoxia & Survival". URMC Pharmacology & Physiology Seminar Program.

"Sirtuins & Cardioprotection". URMC 5th Annual Aging Research Day

"Less is More: Mitochondrial ROS & Oxygen Tension". URMC Special Symposium on Research in Hypoxia, Department of Pediatrics.

2010 "Protein Post-translational Modifications". URMC Proteomics Center Symposium

2014 "Insights into Cardioprotection Mechanisms using Metabolomics". URMC Cardiovascular Research Institute (CVRI) Seminar Series

"Mitochondrial K^+ Channels, Sirtuins & Metabolomics in Cardiac Ischemia". URMC Department of Anesthesiology, Grand Rounds.

2015 "Sirtuins in the heart". URMC Aging Research Day.

"Cardioprotective Drugs: Research Update". URMC Department of Anesthesiology, Grand Rounds.

2017 "Novel Signaling in Tissue Ischemia". URMC Department of Anesthesiology, Grand Rounds.

"Acidosis & Metabolic Signaling in Cancer & Beyond". University of Rochester Annual Genetics Day.

2018 "From leaking lizards to hypoxic hearts: Adventures with mitochondria". URMC Second Friday Science Social seminar series.

2019 "Acidosis & Cardioprotection". URMC Anesthesiology Grand Rounds.

"Anesthetic Preconditioning: A Basic Science Perspective". URMC Anesthesiology 50th Anniversary Symposium.

2021 "Methylglyoxal and Mitochondria in Heart Attack". URMC Lung Biology Research Program Seminar.

"Scientific Image Manipulation and its Consequences". URMC Pathology Seminar Series.

2023 "Anesthesiology has a Scientific Integrity Problem". URMC Anesthesiology Grand Rounds.

"Mitochondrial Complex I Reversal". URMC Cardiovascular Research Institute Seminar Series.

CONFERENCE ORGANIZATION

2006 Chair, Plenary Session on "Mitochondrial Modifications: Proteins, DNA & Lipids" (4 speakers). SFRBM Annual Meeting, Denver CO. (Co-Chair: Aimee Landar).

2009 Chair, break-out session (Oral selected abstracts) on "Mitochondria & Drug Targeting". SFRBM Annual Meeting, San Francisco CA.

2011 Chair, Plenary Session on "Mitochondrial Redox Signaling and Cancer" (4 speakers). SFRBM Annual Meeting, Atlanta GA. (Co-Chair: Sruti Shiva).

2009-2012 Organization of 4 x 1 hr. Professional Development Workshops at SFRBM Annual Meetings.

2015 American Physiological Society conference on "Physiological Bioenergetics: From Bench to Bedside". Co-chair w. Victor Darley-Usmar, Sruti Shiva, Shannon Bailey, Russ Swerdlow, Yisang Yoon. Tampa FL.

2017 Session Chair, Translational Research in Mitochondria Aging & Disease (TriMAD) meeting. Pittsburgh PA.

2019 Session Chair, Keystone Symposium on Cardiac & Skeletal Muscle Mitochondria. Keystone CO.

2024 11th Annual TriMAD (Translational Research in Mitochondria Aging and Disease) meeting. Rochester NY. Conference Chair/Organizer.

PRESS COVERAGE

2008 "Mini Heart Attacks Lessen Damage from Major Ones: Novel Class of Lipids Suggests New Treatment Approach for Heart Attacks". (Paper #38, PubMed ID: 19050010)
<https://www.urmc.rochester.edu/news/story/index.cfm?id=2301>
Featured in US News & World Report, and *Nature Medicine* **15,** 132-133.

2010 "Probing New Ways to Reduce Damage from Heart Attack, Stroke". (Paper # 45, PubMed ID: 20160716)
<https://www.urmc.rochester.edu/news/story/index.cfm?id=2759>
Featured on Channel 8 CBS Local News

2010 "Exploiting the Body's Own Ability to Fight a Heart Attack". (Paper #47, PubMed ID: 20185796)
<https://www.urmc.rochester.edu/news/story/index.cfm?id=2769>

2013 *Nature Medicine* paper on Complex I S-nitrosation (#69, PubMed ID: 23708290) featured on BBC News <https://www.bbc.co.uk/news/health-22655582>, CNN, several newspapers.

2015 "2.5m grant funds research on preventing damage from heart attack" (reference to award of R01-HL127891).
<https://www.urmc.rochester.edu/news/story/4293>

2018 "Researchers have finally created a tool to spot duplicated images across thousands of papers" Nature 555: 18 (2018) doi: 10.1038/d41586-018-02421-3
https://www.nature.com/articles/d41586-018-02421-3

TEACHING PHILOSOPHY

In didactic lectures (~25 hrs/yr in the URMC graduate and medical schools) I strive to match content with developments in the field. I prefer to use scripted workshops as companion exercises, rather than journal club discussions. I grade strictly, but always try to set clear and consistent exam questions. In research mentoring, I emphasize being present in the lab, and maintain a small group that permits direct mentoring (rather than a hierarchy) and an open-door policy with no fixed office hours. I involve trainees in all aspects of academia, including attending conferences without me, engaging in peer review, candid discussions on funding, administration, and authorship attribution. Mentees are encouraged to apply for extramural funding, and to take advantage of career development opportunities regardless the impact on productivity. Reflecting this approach, my former mentees have forged successful careers as independent faculty and in several industries. Other mentoring roles beyond the University have included VP for Education & Prof-Dev at SfRBM, helping to run an NSF-sponsored program in local elementary schools, annual outreach via Skype-a-Scientist, and drafting guidelines on peer review and other activities for AHA. In keeping with my research integrity interests, I emphasize lab ethics and rigorous standards for data integrity and storage, reproducibility, use of animals, and use of open scholarship tools such as pre-prints and full datasets online.

CLASSES TAUGHT

A. PREVIOUS

2000 – 2003 Integrated Biomedical Sciences (Univ. Alabama Birmingham)
1st year graduate students

4.0 hours on "Glycolysis & the TCA cycle", "Mitochondrial Oxidative Phosphorylation", and "Proteomics"

2001 – 2003 Cellular and Molecular Biology (Univ. Alabama Birmingham)
1st year medical students
3.0 hours on "Oxidative phosphorylation"

2003 – 2017 IND409 Cell Biology
1st year graduate students
5.0 hours on "Membrane structure & function", "Membrane transport", "Mitochondrial energy metabolism", "Mitochondrial signaling", and research paper discussion. Previously taught on "Mitochondrial Pathology".

2004 – 2006 PHP520 Frontiers in Mitochondrial Medicine
1st & 2nd year graduate students
2.0 hours on "Introduction to mitochondria and oxidative phosphorylation"

2004 – 2006 PHP440 Topics in Vascular Biology
2nd year graduate students
6.0 hours paper discussion sessions (topic: free radicals in the vasculature)

2004 – 2017 IND408 Biochemistry
1st year graduate students
4.5 hours on "Mitochondrial Chemiosmosis", "Introduction to reactive oxygen species biochemistry", and "Introduction to Reactive Nitrogen Species Biochemistry".

2004 – 2008 PHP404 Pharmacology and Physiology, a disease-based approach"
2nd year graduate students.
2.0 hours on "Energetics in heart failure" and "Atherosclerosis in heart failure"

2005 – 2012 Medical Pharmacology
2nd year medical students
6.0 hours. Problem Based Learning module

2007 – 2015 IND501 Ethics & Scientific Integrity
1st year graduate & medical students
6.0 hours mentoring group sessions (10 students)

2008 – 2009 "Scientific Reasoning in Medicine"
2nd Year MSTP students
1.0 hour discussing a recent literature controversy in medical research.

2008 – 2019 "Molecules to Cells"
1st Year medical students
2.0 hours on "Mitochondrial Oxidative Stress & Aging"

2016 PHP415 Effective Scientific Communication
1st year graduate students
6.0 hours (4 lectures) on interpreting scientific literature

CLASSES TAUGHT **B. CURRENT**

2003 – HSF110 Human Structure & Function (Cardiovascular Physiology block)
1st year medical students.
12.0 hours Problem Based Learning (PBL) modules 2 & 3, plus **2.0** hours problem set

workshops.

2007 – CVS401, Cardiovascular Biology & Disease
1st year graduate students
2.0 hours on "Cardiac Mitochondria & Metabolism"

2007 – IND447 Signal Transduction
2nd year graduate students.
3.0 hours on "Metabolic Signaling" and "NO• signaling"

2010 – PHP403 Cell & Molecular Physiology
2nd Year graduate students
2.0 hours on "Mitochondrial Physiology"

2013 – PHP404 Fundamentals of Pharmacology
2nd Year graduate students
3.0 hours on "Anti-Arrhythmics" and "Pharmacologic Therapy for Heart Failure".

2016 – IND501 Ethics & Scientific Integrity
1st year graduate & medical students
1.0 hour lecture on "Scientific Misconduct & Plagiarism".

2018 – IND431 Foundations of Modern Biology
1st year graduate students
10 hours lectures & workshops.
Module director: Module 5. Metabolism & Mitochondria.

2018 – PTH510 Current Topics in Experimental Pathology.
2nd year graduate students
2 hours lectures & workshops on "Mitochondrial Pathology"

2020 – GEN508 Biological Systems from Conception to Decline
2nd year graduate students
1.5 hour lecture on "Mitochondrial Genetics"

2021 – PHP623 Principles of Pharmacology.
1st year Masters Students
2 hours lecture on "Cardiac Drugs"

2024 – IND431 Foundations of Modern Biology
Course Director, Fall Semester, 5 modules

GRADUATE STUDENTS

A. GRADUATED

2004 – 2008 Lindsay Burwell, Biochemistry Graduate Program.
Thesis: *"Mitochondrial S-nitrosation and cardioprotection"*.
Winner: Young Investigator Award, 2005 & 2006 SFRBM annual meetings.
Winner: Elon Huntington Hooker Fellowship (2007-2008)
Graduated 06/18/2008
Subsequently: Post-doc' w. Tom Fox, Cornell Univ.
Currently: Tenure Track Assistant Professor of Chemistry, Wells College, Aurora NY.

2005 – 2009 David Hoffman, Biochemistry Graduate Program.
Thesis: *"Regulation of mitochondrial ROS generation and hypoxic signaling by O_2*

tension"

Graduated 10/23/2009

Subsequently: Post-doc' w. George Porter, Rochester, then staff scientist with Lycera Inc., Ann Arbor MI.

Currently: Senior Scientist with Cayman Chemical, Ann Arbor MI.

2006 – 2010 Andrew Wojtovich, Cellular & Molecular Pharm/Phys Graduate Program.

Thesis: *"Interactions between complex II and mitochondrial K^+_{ATP} channels in ischemic preconditioning".*

Recipient: AHA Predoctoral Fellowship, 2008-2010

Winner: Travel Award, URMC graduate student poster day, 2007.

Winner: Young Investigator Award, 2007 SFRBM Annual Meeting

Winner: 2009 Upstate NY Cardiovascular Symposium poster prize

Winner: Travel award, 2010 EBEC meeting, Warsaw Poland

Graduated 03/29/2010

Subsequently: Post-doc' w. Keith Nehrke, Rochester.

Currently: Tenure Track Associate Professor, Rochester.

2012 – 2018 Charles (Owen) Smith, Biochemistry Graduate Program

Thesis topic: *"K_{Na}1.2 Potassium Channels & Regulation of Mitochondrial Function"*

Winner: Poster Prize, 5th Annual Translational Research in Mitochondria, Aging & Disease (TriMAD) conference, Pittsburgh PA, October 2014.

Subsequently: Post-doctoral fellow, URMC Center for Musculoskeletal Research

Currently: Senior Scientist, Cannametrix Inc., Rochester NY.

2014 – 2018 Jimmy Zhang, MSTP Program

Thesis topic: *"Mitochondrial metabolism in cardioprotection"*

Winner: Travel Award, 2015 APS Bioenergetics Meeting

Winner: Upstate NY Cardiac Electrophysiology Society, 2015 Gordon Moe Young Investigator Award.

Recipient: AHA Predoctoral Fellowship, 2017.

Recipient: NIH NRSA F30 Predoctoral Fellowship 2017-2019 (AHA award surrendered)

Subsequently: Medical school component of MD/PhD.

Currently: Cardiology Fellow, Mount Sinai S.O.M.

2018-2022 Alexander Milliken, Pharm/Phys Graduate Program.

Thesis topic – cardiac acidotic metabolism.

Supported by Biochemistry T32 training grant 2019-2020.

Awarded AHA Pre-Doctoral Fellowship 2021-2022.

Subsequently: Post-doctoral fellow in my lab.

Currently: Consultant, AlphaBioCom Inc.

2022-2023 Anya Wang. Pharmacology Masters Program.

Subsequently: PhD Program in Neuroscience, Tufts University Boston.

GRADUATE STUDENTS

B. CURRENT

2023 - Rahiim Lake. Biochemistry Graduate Program.

Supported by Biochemistry T32 training grant 2024-2025

GRADUATE STUDENTS

C. ROTATION STUDENTS

2004 Jason Salter, Biochemistry Graduate Program. (PhD. w. Joseph Wedekind)
2004 Sabrina Seehafer, Biochemistry Graduate Program. (PhD. w. David Pearce)
2007 Cody Spencer, Biochemistry Graduate Program. (PhD. W. Josh Munger)
2008 Karen Schmidt, Biochemistry Graduate Program. (PhD. w. David Pearce)
2009 Antony Leonard, Biochemistry Graduate Program. (left the program)
2009 Vivek Nanda, Pharm/Phys Graduate Program. (PhD. w. Joe Miano)
2010 Adam Olm-Shipman, Pharm/Phys Graduate Program. (left the program)
2011 Stefanie DeVito, Biochemistry Graduate program. (PhD. w. Josh Munger)
2011 Qiuyu (Martin) Zhu, Pharm/Phys Graduate Program. (PhD w. Charles Lowenstein)
2012 Jerry Madwuke, Biochemistry Graduate Program. (PhD. w. Roman Eliseev)
2014 Isaac Fisher, Pharm/Phys Graduate Program. (PhD w. Alan Smrcka)
2016 Brandon Berry, Biochemistry Graduate Program. (PhD w. Andrew Wojtovich)
2018 Jessica Ciesla, Biochemistry Graduate Program. (PhD w. Joshua Munger)
2018 Alan Finkelstein, MD/PhD Program
2019 Kai-Ting Huang, Pharm/Phys Graduate Program (PhD w. David Yule)
2021 Michal Shaposhnikov, Pharm/Phys Graduate Program (PhD w. Brad Berk)
2022 Hannah Clary, Biochemistry Graduate Program. (PhD w. Clara Kielkopf)

GRADUATE STUDENTS

D. PhD. THESIS COMMITTEE MEMBER (*CHAIR)

*Chris Ingraham (PI: Carl Pinkert, Pathology) - Graduated 2007
Yuntao Duan (PI: Shey-Shing Sheu, Pharm-Phys) - Graduated 2007
Marlene Matthews (PI: Bradford Berk, CVRI) - Graduated 2008
*Sarah Hueber (PI: Michael McCabe, Env-Tox') – Graduated Masters 2008
*Jennifer Hom (PI: Shey-Shing Sheu, Pharm/Phys) – Graduated 2009
Ann Rossi (PI: Robert Dirksen, Pharm-Phys) – Graduated 2009
Sabrina Seehafer (PI: David Pearce, Biochemistry) – Graduate 2009
Bradley Smith (PI: Hartmut Land, Genetics) – Graduated 2010
Axel Dessal (PI: Alan Smrcka, Pharm/Phys) – Graduated 2009
Kenneth Barth (PI: Virginia Clark, Micro-Immuno) – Graduated 2009
Samuel Caito III (PI: Irfan Rahman, Env-Tox') – Graduated 2010
*Su Liu (PI: Chawnsang Chang, Immunology) – Graduated 2010
Ryan Loy (PI: Robert Dirksen, Pharm/Phys) – Graduated 2010
Beth vanWinkle (PI: Thomas Gunter, Biochemistry) – Graduated 2010
Matthew Cannon (PI: Carl Pinkert, Pathology) – left the program.
David Dunn (PI: Carl Pinkert, Pathology) – Graduated 2010
Xi-Shi (PI: Bradford Berk, CVRI) – Graduated 2011
Jennifer Head (PI: Paige Lawrence, Env-Tox') – Graduated 2012
Julie Babulski (PI: Mark Noble, Biomedical Genetics) – Graduated masters, 2011

Adam Derr (PI: Robert Quivey, Micro-Immuno) – Graduated 2012
Phillip Rappold (PI: Kim Tieu, Neurobiology) – Graduated PhD 2012 (MD/PhD program)
Mohammed Rahman (PI: Dirk Bohmann, Biomed. Genet.) – Graduated 2012
Aslihan Ambeskovic (PI: Hartmut Land, Biomed. Genet.) – Graduated 2014
*Michael vanMeter (PI: Andrei Seluanov, Biology) – Graduated 2015
Alina Ainbinder (PI: Robert Dirksen, Pharm/Phys) – Graduated 2016
Shihao Xu (PI: Joshua Munger, Biochemistry) – Graduated 2016
Jonathan Baker (PI: Robert Quivey, Oral Biology) – Graduated 2016
Rahul Chandarasekhar (PI: David Yule, Pharm/Phys) – Graduated 2016
*Xiao Tian (PI: Vera Gorbunova, Biology) – Graduated 2016
Xuan Li (PI: Dirk Bohmann, Biomed. Genet.) – Graduated 2016
Rebecca Parodi-Rullan (PI: Sabzali Javadov, University of Puerto Rico) – Graduated 2018
Lacey Favazzo (PI: Steve Gill, Microbiology) – Graduated 2019
Edward Ayoub (PI: Archibald Perkins, Pharm/Phys) – Graduated 2019
Brandon Berry (PI: Andrew Wojtovich, Pharm/Phys) – Graduated 2020
Kyle Swovick (PI: Sina Ghaemmaghami, Biology) – Graduated 2021
Yunpeng Pang (PI: Mark Noble, Biomed Genetics) – Graduated 2022
Janine Cubello (PI: Margot Meyer-Proschel, Biomed Genetics) – Graduated 2022
Rubens Sautchuk Jr. (PI: Roman Eliseev, Pathology) – Graduated 2022
Nicholas Nobiletti (PI: Angela Glading, Pharm/Phys) – Graduated 2022
Jessica Ciesla (PI: Josh Munger, Biochemistry) – Graduated 2023
Marcus Kilwein (PI: Michael Welte, Biology) – Graduated 2023
Amelia Clark (PI: Brian Altman, Cancer Center) – Graduated 2024
Arnav Rana (PI: Xin-Jie Chen, SUNY Upstate Medical Center) – Graduated 2025
Michal Shaposhnikov (PI: Brad Berk, CVRI)
Peter Girardi (PI: Gail Johnson, Pharm/Phys)
Dominic Bunn (PI: Gail Johnson, Neuroscience)
Roger White (PI: Michael Welte, Biology)

POST-DOCTORAL FELLOWS

2004 – 2009 Sergiy Nadtochiy. PhD from Bogolometz Institute of Physiology, National Academy of Sciences, Kiev, Ukraine.
Winner, Travel Award, 2007 SFRBM Annual Meeting.
Currently: Tenure Track Assistant Professor, URMC

2010 – 2011 Andrew Wojtovich, PhD from Univ. Rochester (Brookes Lab).
AHA Post-Doctoral Fellowship Award 2011-2013 (co-PI w. Keith Nehrke)
Currently: Tenure Track Assistant Professor, URMC.

2015 – 2017 Yves T. Wang. PhD from Case Western Reserve University, Cleveland OH.
Currently: Staff Scientist in lab of Thu Le, URMC Nephrology.

2018 – 2021 Chaitanya Kulkarni. PhD in Medicinal Chemistry from Univ. Iowa.
Cold Spring Harbor Metabolomics Course Scholarship Award.
AHA Post-Doctoral Fellowship Award 2019-2020

Subsequently: Senior Scientist, Rheos Pharma, Boston MA.

2022 – 2022 Alexander Milliken, PhD in my lab.
Subsequently: Post-doc' in my lab. Currently: Consultant w. AlphaBioCom Inc.

2024 – Sabarna Chowdhury, PhD from Visva-Bharati University, West Bengal, India.
Cold Spring Harbor Metabolomics Course Scholarship Award.

OTHER MENTORING

1993 – 1997 Supervisor for undergraduate biochemistry practical classes. Department of Biochemistry, University of Cambridge, England.

1993 – 1997 Mentoring of 1st and 2nd year biochemistry undergraduates. Department of Biochemistry, University of Cambridge, England.

1999 Emmanuel Padilla, High School Summer Intern, "NASA SHARP" program, University of Alabama at Birmingham.

2001 Julie Newcombe, High School Summer Intern, "Project Seed", University of Alabama at Birmingham. Subsequently: Nursing School.

2002 Joseph Wu, High School Intern. Subsequently: Undergraduate, Harvard.

2003 – 2005 Andrew J. Tompkins. Lab' Technician. 3 publications. Subsequently: Medical School, University of Rochester. Currently, Urologist, Rhode Island Med. Ctr.

2005 – 2006 Sara M. Young. Lab' Technician. 2 publications. Subsequently: Medical School, University of Illinois, Chicago. Currently: Pediatrician, Cleveland OH.

2005 Nilda Alicia-Valasquez, Undergraduate Summer Intern, GEBS Summer Scholars program. Subsequently: Graduate student, Yale. Currently: Assistant Professor of Chemistry, Connecticut State University

2006 Wai-Pan Chan, Undergratuate Summer Intern, GEBS Summer Scholars Program. Subsequently: Graduate School.

2008 & 2010 Emily Redman, High School Summer Intern. Work-study (weekly) 10/2008 onwards. Subsequently: Undergraduate Biochemistry, University of Rochester, then Medical School.

2009, 2010, 2012 Marcin Karcz, MD. Medical Resident w. Unity Health System, Rochester NY. Summer research internship (3 mo/yr). Currently: Anesthesiologist, Columbia Univ. NY.

2009 – 2012 VP for Education & Professional Development, SFRBM. Organized 4 x 1 hr. Professional Development Workshops at SFRBM Annual Meetings, and coordinated numerous other PD activities within the society.

2010 Stephanie Guo. 1st year medical student, URMC. Summer research internship. Subsequently: Critical care MD, Queens Health System, Honolulu HI.

2011 Bruno Queliconi, 3rd year graduate student, University of Sao Paolo, Brazil. Summer research internship. Subsequently: Post-doc' @ UCLA then UCSF.

2011 Andrew Walters. 2nd year medical student, URMC. 1 year internship under "Academic Research Track" program of Clinical & Translation Sciences Institute. Subsequently: Anesthesiologist, UW Health System, Seattle WA.

2012 Boris Boruvcanin. Undergraduate Summer Intern, GEBS Summer Scholars program. Subsequently: Masters, SUNY Buffalo. Medical School, Krakow Poland.

2013 Rebecca Parodi-Rullan (graduate student w. Sabzali Javadov, Univ. Puerto Rico). SFRBM Mini-Fellowship for 2 month visit to my lab' to learn Langendorff mouse heart perfusion

method. Subsequently: Post-doc' at Temple Univ., Philadelphia PA.

2014 Marcin Karcz, MD. URMC Anesthesiology Resident. Mentored through application and award of FAER (Foundation for Anesthesia Education and Research) fellowship application, providing 1 yr. of protected research time, topic "Nornicotine and Cardiac Ischemia".

2015 Nicholas Gulati. Biomedical Engineering Undergrad', Rochester Institute of Technology. 2month internship (RIT co-op program) to 3D print electrodes for cardiomyocyte stimulation inside Seahorse XF analyzer.

2017 Irma Concepcion-Ruiz. Tulane University. Undergrad summer research intern, GEBS summer scholars program.

2018 – 2019 Megan Ngai. University of Rochester, Biochemistry Undergraduate Honors Research.

2019-2020 John E. Kelley, University of Rochester, Biochemistry undergraduate research for credit.

2020 Ahmed Subeh, Monroe Community College undergrad', research shadowing program.

2022-2023 Caio Tabata Fukushima. University of Rochester, Biochemistry undergraduate. Summer research project, then IND395 honors research for credit.

INSTITUTIONAL SERVICE

2002 – 2003 Director, "Advances in Free Radical Biology" seminar series, Center for Free Radical Biology, Univ. Alabama at Birmingham.

2003 – 2004 Coordinator, Mitochondrial Research Interest Group (MRIG) biweekly meetings, University of Rochester.

2005 – 2013 Member, Institutional Mass Spec'/Proteomics Core Facility Steering Committee, University of Rochester.

2005 – pres' Director, Weekly seminar program, Cellular & Molecular Pharm/Phys (CMPP) graduate school cluster, University of Rochester

2004 – 2015 Member, Graduate Student Recruitment/Selection Committee, Biochemistry & Molecular Biology (BMB) Cluster

2004 – pres' Member, Department of Anesthesiology Research Committee

2010 – 2014 Member, Ad-Hoc promotion/tenure committee.

2010 – 2015 Review of applications for intramural bridge funding and internal University Research Awards (approx' 2-3 ad-hoc review committees/year).

2011 – 2017 Member, Faculty Senate (2 x 3 yr. terms)

2014 – 2015 Faculty Search Committee, Department of Pharmacology & Physiology

2015 – pres' Advisory Committee, Pathways Discovery Resource (High Throughput Screening Core)

2015 – 2016 Graduate Curriculum Planning Committee (Med. Sch. group to advise Dean for Graduate Studies on directions/planning for PhD curriculum).

2017 Chair, Faculty Committee on Divestment of University Endowment from Fossil Fuels

2017 – pres' Member, UCAR - University Committee on Animal Resources (aka IACUC). Vice chair since 2021.

2017 – 2018 Graduate Curriculum Committee, to devise and implement new modular course ("Foundations of Modern Biology") for all first-year graduate students.

2020 – 2025 Member, Research Policy Committee of the Faculty Senate.

2024 – 2026 Member, Faculty Senate Sub-Committee on the use of generative artificial intelligence (GenAI) in research.

CONSULTING

2009 – 2010 Galleon Pharmaceuticals Inc., Horsham PA.
Consulting agreement comprising testing of proprietary compounds provided by Galleon, in biochemical and physiological assay systems in my laboratory. Expenses payable into a research account for coverage of research expenses only.

2011 Lycera Pharmaceuticals, Ann Arbor MI.
Consultant, advising on mechanisms of action of novel therapeutics for inflammatory diseases. Honorarium for single SAB meeting (no research support).

2011 – 2013 Radikal Therapeutics Inc., West Tisbury MA.
CNDA in place for ad-hoc consultations regarding mechanisms of action of novel therapeutic agents for lung and heart diseases.

2016 Krenitsky Pharmaceuticals Inc. Raleigh-Durham NC
CNDA in place for consultations regarding mechanisms of action and potential cardiac indications for compound KP544.

2017 Calico Inc. (Google), Mountain View CA.
Consultation on cardiovascular research methodology

OTHER WRITING

Brookes PS. (2009) "Playing with Fire: Francis Collins and the National Institutes of Health". Op Ed. The Humanist (magazine of the American Humanist Association), July 2009 issue.

Brookes PS. (2016) Response: "A Good Little Girl". Letter to ASBMB Today (magazine of the American Society for Biochemistry & Molecular Biology). November 2016 issue.

PROFESSIONAL DEVELOPMENT

2003-2023 Regular annual training in MyPath platform for various Prof-Dev activities including implicit bias training, sexual harassment training, conflict-of-interest training, and familiarization with novel software platforms as they are launched.

2022 In-person training on DEI with T32 Biochemistry Training Grant (CIMER program)

2023 VALOR leadership program, administered by URMC Faculty Development Office, including online activities and monthly coaching sessions.

2024 – Part-time Executive MBA at the Simon Business School, University of Rochester (expected graduation May 2026).

OTHER

2022 – Pres Certified level 2 mountain biking coach, National Interscholastic Cycling Association (NICA). Advanced First-Aid / Lifesaving Certification, American Red Cross.

REFEREES

Michael Scott, MD (Department Chair)
UMRC Department of Anesthesiology
Michael_Scott1@urmc.rochester.edu Tel: (585) 273-1190

Victor M. Darley-Usmar, PhD (Post-doc' Mentor)

Professor of Pathology, Univ. Alabama at Birmingham.
darley@uab.edu Tel: (205) 934 4612

ONLINE

Lab Website & Blog: www.psblab.org
LinkedIn: www.linkedin.com/in/paul-s-brookes

Updated May 2025

EXHIBIT 3

PAUL S. BROOKES, PHD ~ RESEARCH INTEGRITY CV

CONTACT Anesthesiology, Univ. Rochester Med. Ctr., 601 Elmwood Avenue, Rochester, NY 14642, USA.
Office: (585) 273-1626 Cell: [redacted]
Work: paul_brookes@urmc.rochester.edu Private: [redacted]
Web: www.psblab.org LinkedIn: paul-s-brookes

PERSONAL [redacted].

ACADEMIC RESEARCH CAREER

EDUCATION 1993 BSc Biochemistry, Univ. College London UK | 1997 PhD Biochemistry, Univ. Cambridge UK | 2026 (expected) MBA, Simon Business School, Univ. Rochester.

CAREER 1998 Post-doc', UAB, Birmingham AL | 2003 Asst. Prof. Anesthesiology, Univ. Rochester | 2008 Assoc. Prof | 2015 Full Prof. w. tenure.

FUNDING >$8m direct costs from grants as Principal Investigator. Continuous NIH funding since 2003.

SCHOLARSHIP 156 scientific articles, reviews & book-chapters | 3 patents | Scopus *h*-index 63.

RECOGNITION 100+ international conference plenary lectures & speaking invitations | Numerous editorial boards & grant review panels | Elected fellow of the American Heart Association.

TEACHING 45+ hrs lecturing & workshops annually | Mentored dozens of PhD students, post-doctoral fellows, undergraduates, & high-school interns.

UNIV. SERVICE 2011–2017 Faculty Senate | 2019-2025 Research Policy Committee | 2017– University Committee on Animal Resources (2021– Vice Chair).

RESEARCH My lab studies metabolism and mitochondria in cardiac ischemia-reperfusion (IR) injury and cardioprotection, using murine cardiomyocytes, perfused hearts, and metabolomics (LCMS). Key interests include: (i) Acid pH and methylglyoxal as protective signals in IR. (ii) Screening and development of mito-targeted drugs. (iii) Mitochondrial reactive oxygen species. Our goal is to understand, then target metabolic events in IR with novel drugs for therapeutic benefit.

RESEARCH INTEGRITY & OPEN SCIENCE

OVERVIEW My interest in research integrity was triggered in 2010 by discovery of fabricated data in a grant proposal. In 2012 I started the anonymous blog science-fraud.org, which reported on almost 300 problematic papers from 75 labs. I was forced to close the site after being *doxxed*, and 6 scientists threatened to sue me for defamation. A paper ensued, on how internet publicity impacts the fate of problem papers. My efforts have resulted in hundreds of retractions and several misconduct findings by the federal Office of Research Integrity (ORI). Today, I continue to write on research integrity at my lab' website, post findings on PubPeer, and serve as a β-tester for AI tools to detect misconduct. I also teach research ethics and have served as an invited speaker and forensic research integrity consultant. I am a strong proponent of open science, overseeing Rochester's adoption of an open access policy. Since 2016 I have posted pre-prints on BioRxiv and full data sets on FigShare. **Key misconduct cases I have originated or been involved in reporting, are outlined below:**

AGGARWAL	In 2011 I found 140 problems in 75 papers from Bharat Aggarwal at MD Anderson Cancer Center and published these with Japanese Blogger Juichii Jigen. Aggarwal tried and failed to sue me and Retraction Watch, retracted 44 papers and retired to India.
DONMEZ	In 2011 I reported on problem papers by Gizem Donmez of Tufts Univ., a former post-doc' of Harvard's Leonard Guarente. It took many years of fighting with COPE to obtain retractions. Donmez was fired, and tried/failed to sue me (using the same law firm as David Baltimore).
CHANG	Chawnshang Chang was a professor at my University (Rochester). Despite my numerous misconduct reports and follow-up requests, an investigation only occurred in 2021 after Leo Schneider's input. No misconduct was found, but Chang was let go and moved to China.
KUMAR	Rakesh Kumar was a Dept' Chair at George Washington University in DC. Following my reporting, he lost his job, retracted 5 papers, and failed in suing myself and Retraction Watch.
ROTTLAENDER	Misconduct in the lab of Uta Hoppe, of Univ. Cologne, was attributed to a post-doc Dennis Rottlaender, who was fired after 2 retractions.
LEE	My reporting on Sam W. Lee resulted in many retractions, his departure from Harvard, an astroturfing campaign, a failed attempt to sue me, and a >$200k federal settlement. He also sued his next employer Yale, who countersued after learning about the misconduct.
MORGAN	My reporting led to 4 retractions from Cardiff research Dean, B. Paul Morgan, attributed to a post-doc (Rossen Donev). Morgan was cleared and immediately retired, but 4 problem papers without Donev as author remain in the literature.
SAAD & CURI	I documented re-use of a blot image 15 times in 10 Mario Saad papers. Rui Curi tried & failed to sue me. Publicity of this case led to Saad's failure to win election as Rector of his University.
PASTORINO	John Pastorino of Rowan University retracted a *JBC* paper in 2016. I traced the data to an NIH grant application, resulting in an ORI investigation, a funding ban, and 8 retractions.
AGGARWAL	My first case, reporting on faked images in an AHA grant proposal by Wisconsin post-doc' Nitin Agarwal. An ORI investigation led to 2 retractions, job loss, and a funding ban.
EZZAT/ASA	Following my reporting, Husband and wife team Shereen Ezzat & Sylvia Asa of Univ. Toronto had numerous retractions and were forced to close their lab.
OTHER CASES	Sanjeeb Sahoo (nanotech), Claudio Hetz (prions), Claudio Soto (prions), Rosie Xing (aging), Giovanna Malluci (prions), Dekubmar Pain (mitochondria), Shazib Pervaiz (mitochondria), Mark Stearns (cancer), Francesco Stellacci (nanotech), Ratna Vadlamudi (cancer), David Westaway (neuroscience), John Holloszy (aging), Teresita Briones (cancer), Gang Shu (metabolism), Alexandru Biris (nanotech).
PAPERS	Brookes PS (2014) Internet publicity of data problems in the bioscience literature correlates with enhanced corrective action. *PeerJ* 2: e313. DOI: 10.7717/peerj.313 Brookes PS (2025) Misconduct Detection - Evolving Methods & Lessons from 15 Years of Scientific Image Sleuthing. *J. Law Med. Ethics.* In Press DOI: 10.1017/jme.2025.32

EXHIBIT 4

1. Standards and expectations for use of western blotting to quantify protein content in biological samples

Paul S. Brookes, PhD, Professor of Anesthesiology, University of Rochester Medical Center

Contents:

1. Outline

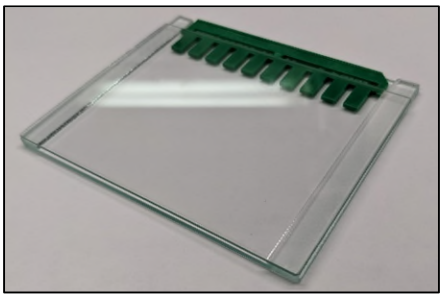
In this document I will describe the process of western blotting, and accepted standards in the biomedical sciences for the preparation, presentation, and quantitation of western blot data. This is based on my experience with this method for over 20 years, and appropriate citations. After describing the experimental procedure and the necessary quality controls to obtain reliable data, discussion will cover common mistakes, manipulations or other issues that can undermine confidence in conclusions arising from blot data.

2. Purpose of western blotting and method overview

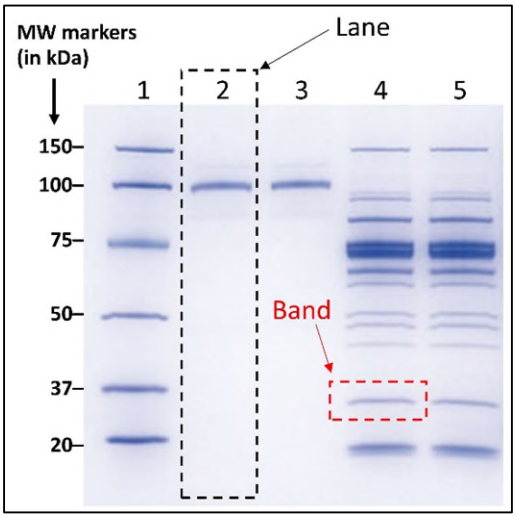
In biomedical science it is often necessary to quantify the amount of a protein and how this responds to a perturbation (e.g., a drug treatment). Western blotting is one method to achieve this, and comprises 3 steps: (i) Proteins in a sample are separated by their molecular weight using gel electrophoresis (SDS-PAGE) and the separated proteins are then transferred to a membrane. (ii) The membrane is probed using an antibody that binds to the protein of interest. (iii) The amount of antibody binding is quantified via chemiluminescence. At each step, quality controls are necessary to ensure the eventual readout reliably reports the amount of protein in each sample. Such controls include use of a *molecular weight ladder* (a mixture of proteins of defined size) to calibrate the gel, and the use of *loading controls* to ensure the same amount of total protein from each sample is loaded onto the gel. A key principle throughout, is that all samples and steps must be treated equally.

(i) Step 1, SDS-PAGE and membrane transfer

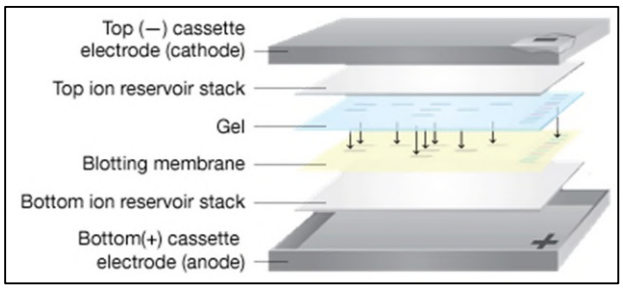
Biological samples (e.g., cells, tissues, homogenates) are extracted in liquid form, by boiling them in a solution containing the detergent sodium dodecyl sulfate (SDS) and the chemical β-mercaptoethanol. This causes proteins in the sample to denature (unfold). SDS coats the proteins and imparts a negative charge on them. A protein assay can be performed to quantify the total amount of protein in each sample. However, this is not always possible (as SDS can interfere with some commonly used protein assay methods), so a more common procedure is to use a *loading control* at a later stage. The proteins dissolved in SDS are separated by gel electrophoresis. Two glass plates are separated by a thin spacer (typically 1.5mm thick), and a mixture of acrylamide/bis-acrylamide is poured into the gap, along with agents that cause the acrylamide to polymerize and solidify. An extra layer of gel is then poured and set, with a plastic comb used to create slots in the top of the gel. When the comb is removed, the spaces left behind are called *wells*. The typical gel has 10 or 15 wells, so can be used to analyze 10 or 15 biological samples. The image on the left shows a glass plate assembly with a 10-well comb.



The polymerized gel is placed in a *gel-box* apparatus, comprising a tank filled with a solution containing SDS. The solution conducts electricity, and located within the tank are platinum electrodes. The cathode (negative) is located at the top of the gel, near the wells. The anode (positive) is located near the bottom of the gel. The protein samples are loaded by pipetting into the wells, and the gel box is then connected to a power supply (10-100 Volts DC) for 1-3 hours. The electric charge across the gel causes the proteins (negatively charged with SDS) to migrate down the gel toward the anode. The gel matrix contains pores that act as a sieve to slow down the proteins, such that small proteins move quickly through the gel, while large proteins move slowly. When preparing a gel, the percentage acrylamide determines the pore size… 12-15% gels are used to separate large proteins, 5-10% for smaller proteins. At the end of the run time, the result is a separation of proteins below each well, with large proteins at the top near their starting point, and smaller proteins at the bottom having migrated further. The vertical space below each well is termed a *lane*, and within each lane the proteins appear as horizontal *bands* (see image at left).

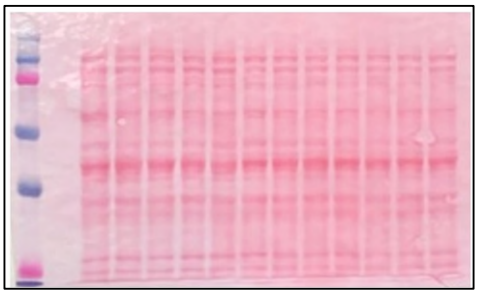


It is usually necessary to calibrate the gel by loading *molecular weight markers* in one of the wells. This is a mixture of proteins of known molecular weight (MW), often tagged with colored dyes so their position on the gel can easily be seen. In the image above, the markers are loaded in lane 1, and their molecular weight (in kiloDaltons, kDa) is annotated alongside the gel. The vertical position of a protein relative to the MW ladder is used to calculate its size (here the red highlighted red band has a mass between 20 and 37 kDa). When probing multiple proteins on a single western blot, it is critical to use a MW ladder so the membrane can be cut into horizontal slices (representing different MW ranges) to probe with different antibodies.



Gels are very fragile, so the next step is to transfer the separated proteins to more stable substrate. The substrate of choice is a membrane of nitrocellulose or PVDF – both materials that bind proteins well. The transfer process (see image at left) is termed *western blotting*, with the resulting *blot* being an imprint of the gel. It is common to mark the membrane (e.g., a nick in one corner) to orient it relative to the original gel at a later stage. An important feature arising from the above process, is that no two gels or membrane blots are identical.

(ii) Step 2, probing the membrane with antibodies



At this stage, the MW marker proteins usually appear on the membrane as colored bands visible to the naked eye, whereas the rest of the membrane appears blank white. To check that the transfer occurred correctly, it is common to stain the membrane with the dye Ponceau red (see image at left), which can then be washed away before processing the blot further. Because the membrane binds protein, and antibodies themselves are proteins, before the antibody incubation step it is necessary to *block* the unoccupied protein binding sites on the membrane, by incubating it with a uniform protein solution. Typically, non-fat dry milk (casein) or bovine serum albumin are used as cheap sources of blocking protein.

The *blocked* membrane is then probed with an antibody that specifically binds to the protein of interest - this is termed the *primary antibody*. Typical antibodies for biomedical science are raised in mouse or rabbit. Mouse antibodies are usually *monoclonal* and bind to a very specific part of a protein (termed an *epitope*). Rabbit antibodies are usually *polyclonal* and less specific. Because protein sequence or structure can vary between species, antibody reactivity may vary across species (e.g., an antibody against a rat protein may *cross-react* with the equivalent mouse protein, but not the equivalent human protein).

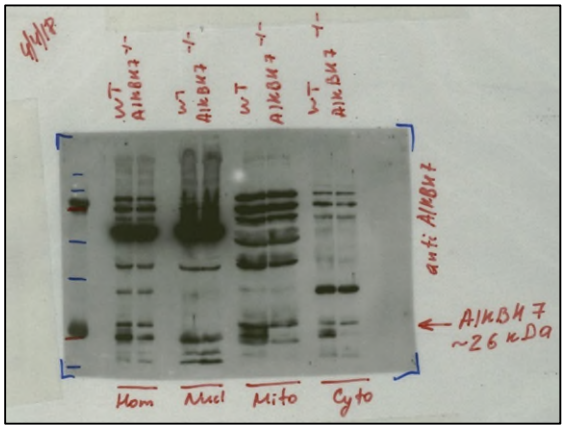
Following primary antibody incubation, the membrane is washed to remove unbound antibody. The membrane is then incubated with a *secondary antibody*, which binds to the primary antibody and labels it. The secondary antibody is tagged with an indicator – usually the enzyme horseradish peroxidase (HRP) or a dye or fluorescent molecule. The membrane is washed again to remove unbound secondary antibody, and then subjected to a detection method, to quantify the amount of antibody binding.

(iii) Step 3, detection and quantitation

The final stage is to quantify the amount of the protein of interest, typically using chemiluminescence. The membrane is incubated in a mixture of chemicals that react with each other in a manner that is dependent on the enzyme HRP, generating a product that is luminescent (it emits light). Thus, wherever the antibody was bound to the protein of interest, that part of the membrane will light up. Quantitation of the emitted light is then performed by one of two methods:

(a) Film detection. The membrane is placed in transparent wrap (saran wrap or a clear plastic page separator) and attached to a backing plate in a metal radiography cassette. In a dark-room, a piece of x-ray film is placed into the cassette next to the membrane, typically for 1-10 minutes. Depending on the intensity of the signal

it is often necessary to try several different lengths of film exposure, to obtain a satisfactory image that is acceptable for quantitation (see discussion of dynamic range below). The film is then removed from the cassette and put through an automatic developer machine. Wherever light was emitted from the membrane, this burns a dark spot on the film. The position of the film relative to the membrane, and the position of the MW markers, are usually documented by writing directly on the developed film with a marker pen. The resulting film can be stored indefinitely, and digital images of it are usually captured with a conventional flat-bed scanner. Shown on the left is a scanned image of a piece of film, with the membrane edges marked in blue, MW markers on the left, and various other labels.



(b) Digital blot imaging. Advances in digital camera sensitivity, and the expense and toxicity of developing reagents, have led most labs to adopt digital blot imaging over the past two decades. In a digital *gel-doc* system, a series of exposures are made to collect a digital image of the chemiluminescent signal. In addition, a conventional photograph (light-field image) of the membrane is collected at the same time, so that the position of the chemiluminescent signal can be oriented to *landmarks* on the membrane (e.g., the MW ladder and the nick cut in the corner) by superimposing the images at a later time.

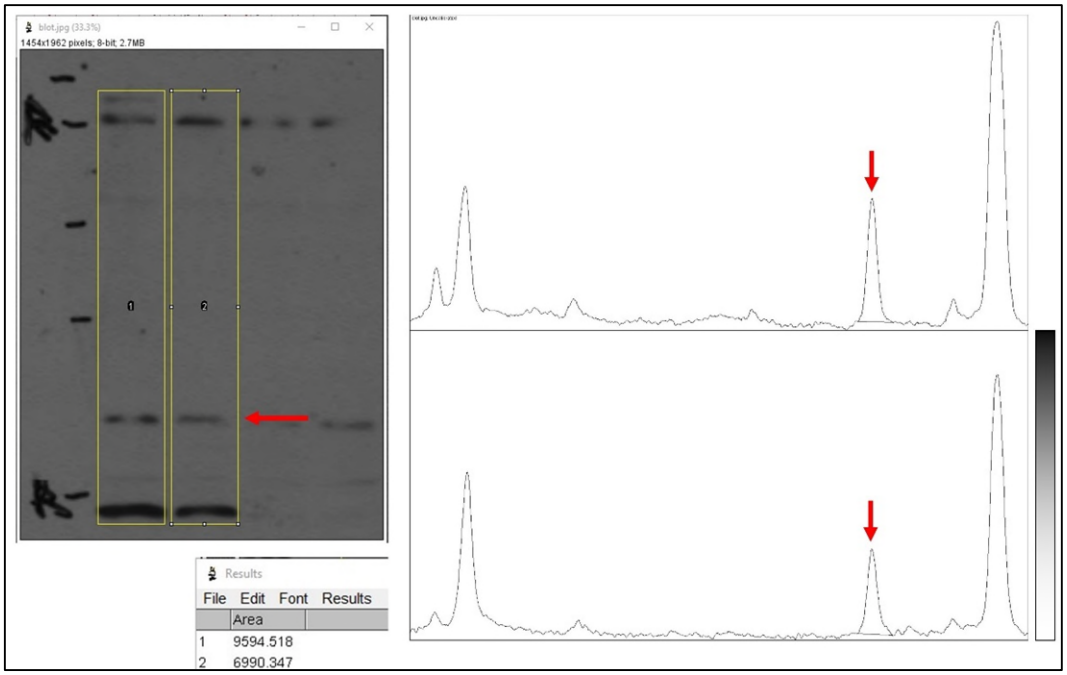
At this stage, the image (either physical or digital) constitutes the *original primary data* for a western blot experiment, and should be archived for future reference. The image may be altered for presentation purposes (e.g., by cropping) but the original unaltered image must be kept.

Recalling the key steps… the density of a band on a blot image is proportional to the chemiluminescent signal, which in turn reports amount of HRP-linked secondary antibody at that position on the membrane. This is determined by the amount of primary antibody bound, which is determined by the amount of the protein of interest. As such, the density of a band indirectly reports the amount of the protein of interest in the sample loaded in a given lane. Comparing band densities allows for relative comparisons between samples.

(c) Quantitation of band density

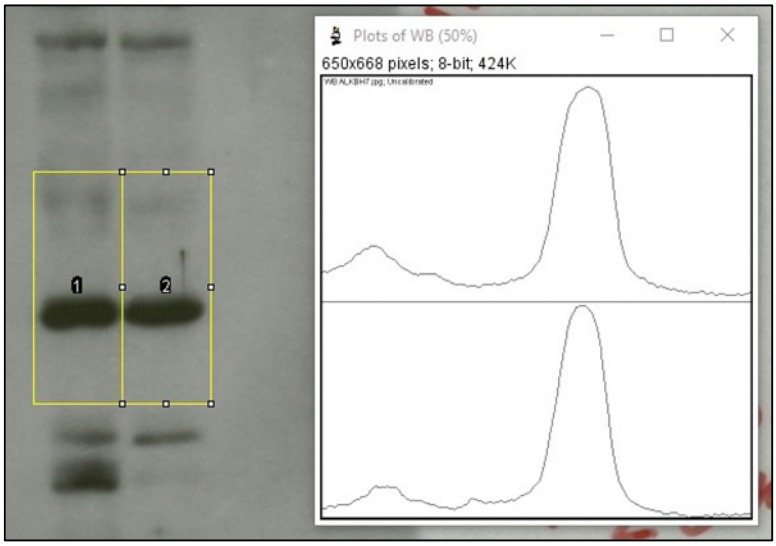
Densitometry (counting pixel density) is used to quantify the amount of a protein in each sample – i.e., to convert the blot image into numerical data. Some gel-doc systems have proprietary software, but the most commonly used software is NIH ImageJ (https://imagej.nih.gov/ij/). The software first requests to outline the lanes on the blot (see image on next page), then it plots a graph of the signal density from top to bottom for each lane. This plot can then be used to determine the area-under-the curve (AUC) for the band of interest in each lane. On the density plot, a pure white background appears as zero on the y-axis, intermediate shades (gray) in between, and a pure black band as 100.

When quantifying blots, it is rare for investigators to run authentic protein standards of known quantity alongside unknown biological samples. Thus, densitometry usually reports the relative amount of a protein between samples (e.g., sample A has three times more of the protein compared to sample B). A key issue in such comparisons is the limited dynamic range of the method (typically 10-15-fold), and a critical determinant of this range is the saturation of the blot image, determined by the exposure time. In this regard, digital imaging offers some advantages, because different exposures can be captured in composite, to extend the dynamic range of the method.



In the example at left, the blot image is shown with lanes highlighted in yellow using ImageJ software. The band of interest is indicated by a red arrow. The density plots for each lane are shown (left to right on each plot equals top to bottom on each lane). The peak corresponding to the band of interest is shown by the red arrows. Finally, the small box below the blot image shows the quantitative data from the 2 peaks (i.e., pixel density counts). In this case, the sample in lane 1 has 9594.5 units of protein, and lane 2 has 6990.3 units.

A general rule regarding saturation, is that protein bands must appear Gaussian, to qualify as non-saturated. If a band appears solid black, it will yield a density plot that is clipped or rounded at the top, indicating the signal is over-saturated. The resulting AUC will not accurately reflect the amount of protein present. In the example on the left, the peaks are rounded at the top, so the bands are not suitable for quantitation – the signal is *oversaturated* and beyond the dynamic range of the method. Many western blot images in the literature are over-saturated and unsuitable for quantitation. This issue can become especially problematic when the properties of an image are altered to render it more attractive for publication, by adjustment of the contrast/brightness, resulting in solid black bands on a solid white background.

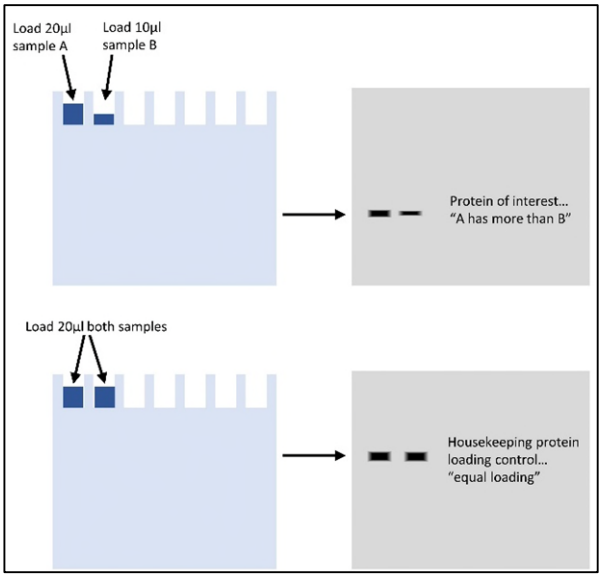


3. Loading controls

To quantify a protein of interest, it is required to normalize the signal to the amount of sample protein originally loaded on the gel. Some proteins in cells are present at relatively constant levels and are termed *housekeeping* proteins. Common examples are the enzyme glyceraldehyde-3-phosphate dehydrogenase (GAPDH) or the structural proteins β-actin or tubulin. Probing the membrane with an antibody against a housekeeping protein gives a proxy for the total amount of protein loaded in each well. An alternative normalization method is to use the Ponceau red stained membrane image (see step 2, above) to show the total protein in each lane. In best practices, a *loading control* image should be obtained from the same membrane as the one for the protein of interest. Typically, one chooses a housekeeping protein of a different MW than the protein of interest. The blot membrane is then cut into horizontal slices, and the membrane

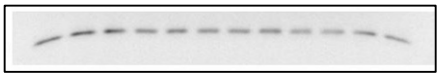
pieces probed with different antibodies – one for the protein of interest and one for the housekeeping protein.

If the protein of interest and the housekeeping protein are too close in MW to permit cutting the membrane, it is sometimes possible to probe with one antibody, then *strip* the membrane and re-probe with another antibody. However, such procedures are difficult and do not always work, as harsh stripping procedures may damage the membrane or the protein epitopes.



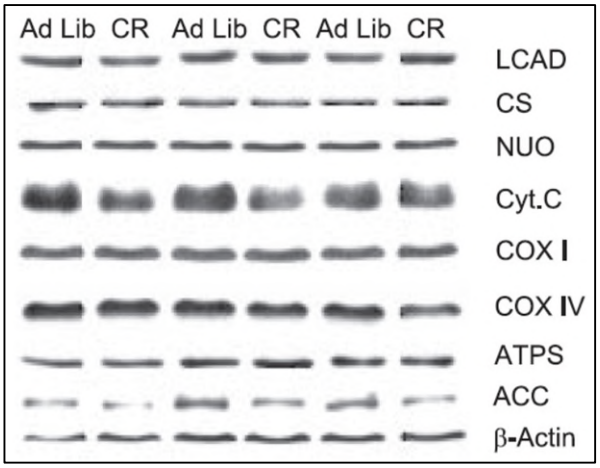
(i) Running loading controls on a separate blot

Sometimes it is simply not possible to run a loading control on the same membrane. In such cases, it can be acceptable to run a separate gel/membrane with the same samples. However, it is important to recognize that this introduces significant opportunity for misconduct. In the example shown on the right, if an investigator wanted to prove that sample A had more of a protein of interest than sample B, they could load more of sample A on the gel, and probe the blot with the relevant antibody. Then, a separate loading control blot could be constructed by loading with equal amounts of sample. *Normalizing* the protein of interest blot to the loading control blot would give the desired result, even though it is entirely fabricated.



(ii) How to tell if loading controls come from the same blot?

When a blot is horizontally sliced, to probe for more than one protein, several features should be preserved across the different slices. For example, a common feature of SDS-PAGE gels is they do not run evenly, resulting in a *smile* or *frown* shape in the final bands across the gel (see example image above). If one blot image in a series has a smile/frown, then the others should have the same feature.



Likewise, the spacing of bands should be similar, as well as their sizing, shape and slope (left to right). In the example on the left here, we are expected to believe that the authors ran a single gel, cut the membrane up into 9 horizontal slices and probed each with a separate antibody. Clearly many of the bands show different features (e.g., the ACC bands on the right side of the image are sloped upwards from left to right, whereas the β-actin bands are cupped, and the COX-I bands have less space in between them). The more likely explanation is that these bands originated from several blots, and so the β-actin blot is not a true loading control. In such cases when it is clear that loading control images originate from separate gels/blots, it is often necessary to request full-sized original blot images as supplementary supporting data.

4. Rules and standards in preparing blot images for publication

The standard rules, accepted in the field for almost 20 years, are widely referred to as the "JCB guidelines" (Rossner & Yamada, 2004. *J Cell Biol.* vol 166, p11. https://doi.org/10.1083/jcb.200406019). The *golden rule*

is that if an image is to be manipulated, all parts must be adjusted equally. It is absolutely unacceptable to apply selective enhancement or other adjustments to only some parts of an image and not others. A critical principle from the guidelines is as follows:

> *For every adjustment to a digital image, it is important to ask, "Is the image that results from this adjustment still an accurate representation of the original data?" If the answer is "no," your actions may be construed as misconduct.*

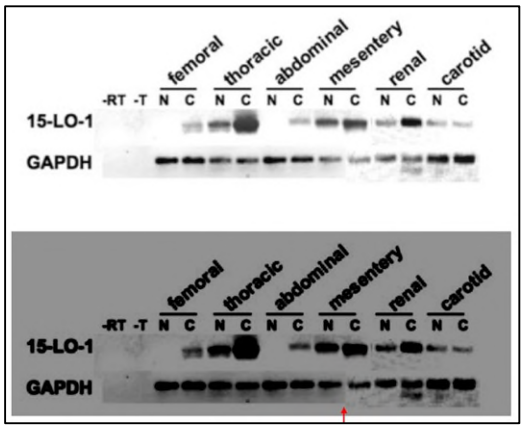
5. Common problems & features when forensically examining blot images

(i) Letterboxing

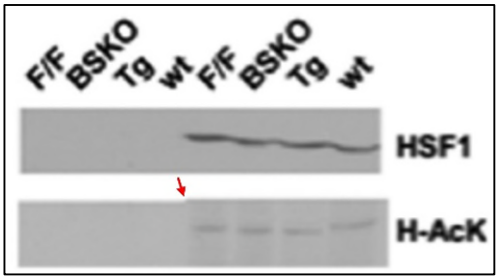
A common practice in published blot images is *letterboxing* – cropping of blot images to show only the protein band of interest, resulting in a horizontal letterbox-shaped image. Although this has been popular for decades (and was likely bought about by space constraints in paper printed journals), many publishers now discourage it and demand original full-sized blot images in a supplementary data file.

The problem with letterboxing is it removes bands from their context. For example, best practices demand to show at least one MW marker (preferably two or more), to allow the reader to see the size of the protein. This is useful to see if the antibody is binding to something at the correct (expected) MW. Proteins are often modified so they run at a different MW, or they may be cleaved or degraded so the antibody binds to a small fragment of protein that runs further down the gel. Perhaps most importantly, MANY commercially available antibodies are known to recognize off-target proteins (e.g., Foster *et al.*, 2008, *Biochem. Biophys. Res. Commun.* vol 366, 649 https://doi.org/10.1016/j.bbrc.2007.11.154). For this reason, showing a taller swath of blot image is preferred practice and is now demanded by many journals as part of their submission process.

(ii) Blot splicing



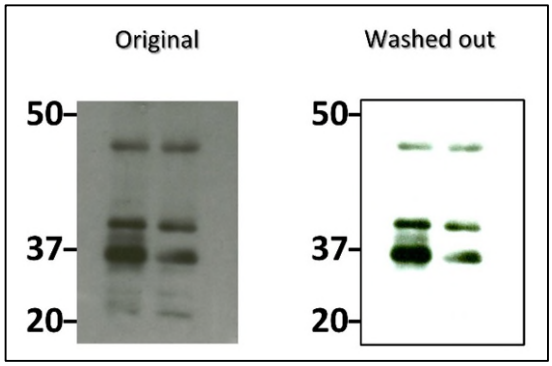
A once common practice now strongly discouraged, is the undisclosed splicing of blot images. If a gel was run with the samples in a different order than desired for publication, it may be necessary to rearrange the bands into the correct order. Doing so MUST be disclosed clearly in the figure legend, with the use of solid lines on the image itself. In the example shown at left (upper image is original published, lower image with enhanced contrast), the GAPDH loading control blot has a vertical splice seam (red arrow), while the 15-LO-1 blot does not. Ergo, the two blot images have been treated differently.



Sometimes, a giveaway sign that a blot has been spliced, is a small *notch* or *nick* along the upper or lower edge of the letterboxed image, as shown in the example on the left. Letterboxed blot images are often presented in stacks, showing several proteins from a series of conditions, with a single loading control at the bottom (see example on previous page). In such cases, it is absolutely forbidden for some blots in a stack to be spliced, and others not spliced – this would indicate the images have been treated differently.

(iii) Resolution & compression artifacts.

During or prior to the publication process, digital western blot images may go through several manipulations, with saving at each stage introducing image compression artifacts. The JPG image format is particularly *lossy*, and can introduce false edges into images that can be mistaken for splicing seams during later forensic examinations. For this reason, when forensically examining images, best practices call for obtaining the highest possible resolution image.



(iv) Washed out blots

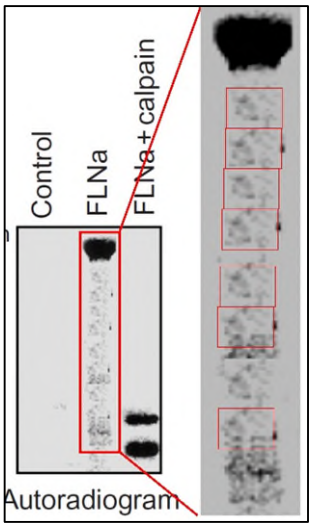
In presenting blots for publication, it is common to enhance the contrast/brightness. However, when this is done to such an extent that the background of the image becomes completely *washed out*, it renders the bands disconnected from any other feature of the image (see example at right). This creates additional potential for misconduct, because it is now impossible to tell if the bands originated as they are seen, or were assembled together artificially (i.e., digitally spliced). Washed out blots are another scenario in which requesting original full-sized images is often necessary, to determine the origin of the bands.

(v) Background noise

A key determinant of whether a blot image is a genuine compound whole, or has been assembled from unrelated images, is background noise. Every blot image is unique, and carries with it pixelation and noise from the various stages of preparation. Sources of this noise include:

- Surface imperfections on glass plates used to pour the gel
- Surface imperfections and particulate matter (bits of gel) that stick to the membrane during transfer
- Fingerprints or dirt acquired during blot processing and development
- Creases in the membrane or plastic wrap overlay used during chemiluminescent development
- Surface imperfections in the x-ray film
- Dust or optical aberrations in the camera (gel-doc) imaging system or the flatbed scanner used to capture the developed film
- Residual chemicals or signal-generating features in the film cassette or imaging system (e.g., chemicals leak out of the plastic wrap).
- Dust or imperfections on rollers or other components of the automatic developer machine

Furthermore, since several stages of the blot process involve positioning things alongside each other, there are numerous opportunities for such noise and other signal imperfections to move relative to each other. For example, scanning the same piece of film on a flatbed scanner twice will give slightly different results each time, even if the film is shifted by <1mm. Likewise, when loading film into an automatic developer machine, the chances of hitting the roller in exactly the same place are essentially zero. For all of these reasons, a simple rule can be applied – NO TWO BLOT IMAGES WILL HAVE IDENTICAL BACKGROUND NOISE down to the single pixel level. Ergo, when two images do appear to share more features than would be expected by chance, it is reasonable to conclude that they share an origin in the digital realm.

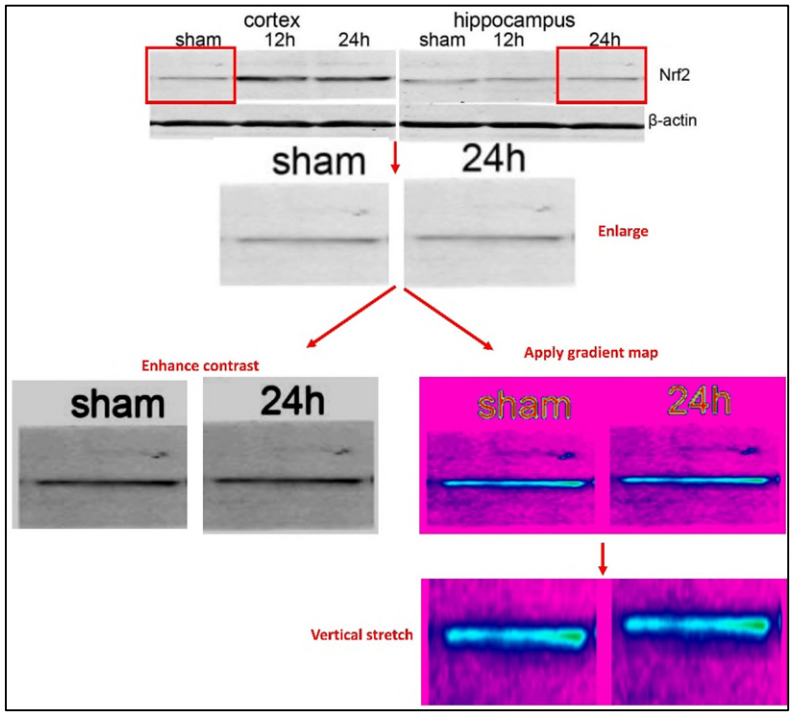


In addition to backgrounds being similar between gels or blots, it is also highly unlikely for the natural background features within a single blot image to be repetitive. In the example shown here, much of the lane beneath the prominent band at the top is filled with what appears to be random pixelated noise. However, closer examination under high contrast reveals a repeating non-natural pattern. The most likely explanation is digital *cloning* of an area of the image.

A common excuse is "there was a speck of dust on the developing machine roller", but this is untenable due to the size of the features… the cloned area is about 5 mm in size, while the rollers in developer machines are ~2" in diameter, ~6" circumference. Thus, any repeating pattern due to roller dirt should repeat every 6" on the film. This excuse also requires us to believe that the operator inserted the film at the same exact point of roller rotation, to capture that exact same speck of dust in the same position on the film.

(vi) Replication of bands and features

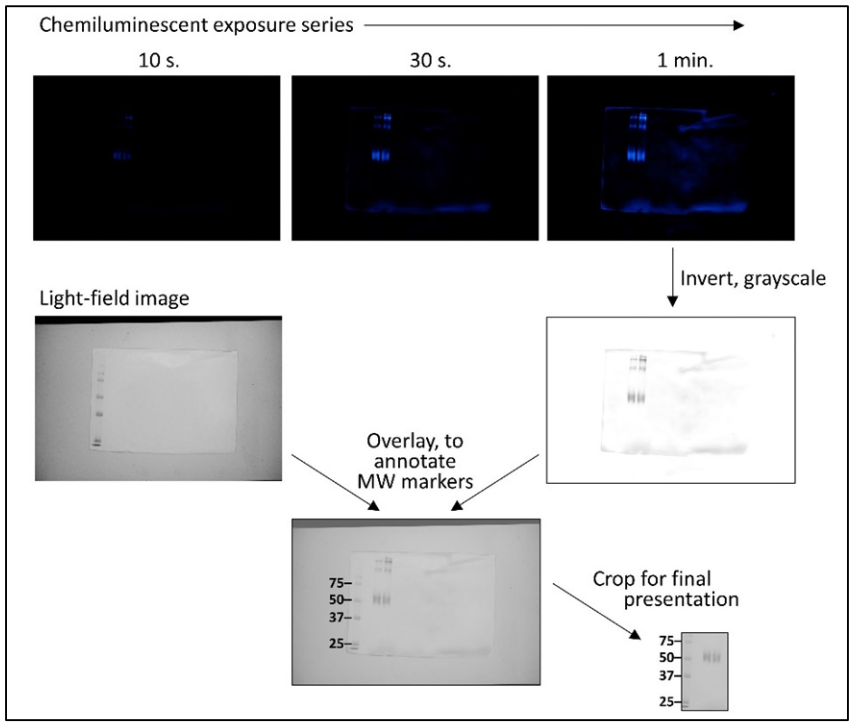
In the same manner that background noise should be unique to every blot image, the shape and size and characteristics of individual bands within a blot should also be unique. As such, although individual bands may appear to be similar, they should never appear identical down to the pixel level. An important feature often used to determine whether bands are identical, is the surrounding imperfections. In the example shown on the left, the bands in the top left and top right corners (red boxes) appear similar. Enlargement, enhancing contrast, and applying a color gradient map (in Adobe Photoshop software) allow the common features to be visualized more easily, leaving little doubt these are the same band.



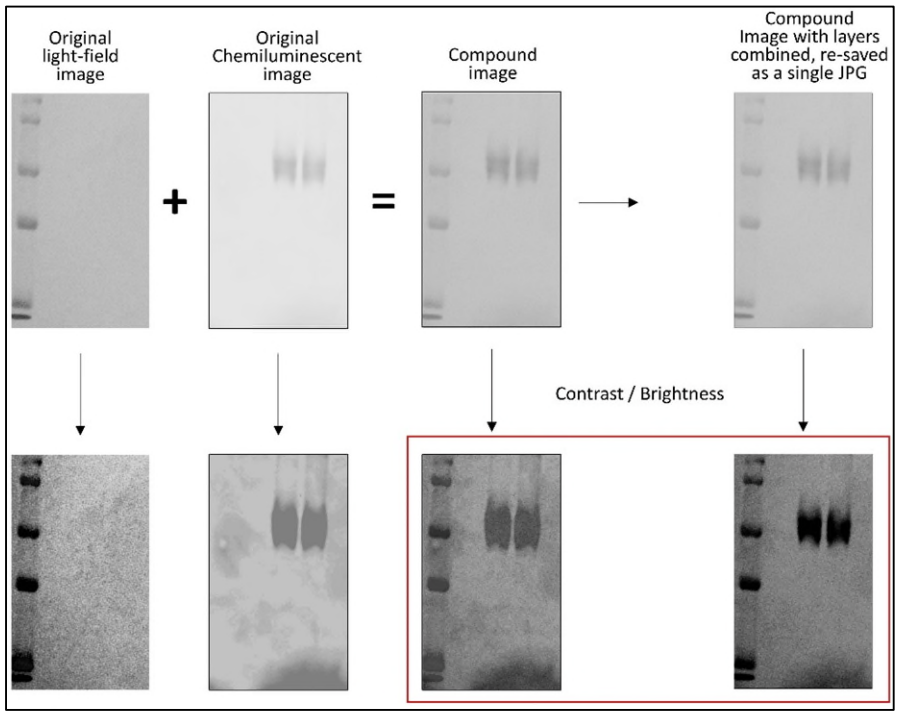
Not only are the background noise features identical, but the bands themselves have identical outlines and edges. Vertically stretching the image (bottom right) can be used to confirm that the gradient within the band itself is the same, confirming that these bands have been inappropriately duplicated. If necessary, image overlay techniques can be used to confirm if two bands are identical down to the single pixel level.

(vii) Compound images

As outlined in the section on blot development, it is common nowadays to digital imaging, in which different times of chemiluminescent exposure can be captured, alongside a light-field image of the membrane with its dye-tagged MW markers. The two images are then bought together in a composite image for presentation. Ideally, all the images including the light-field image of the membrane are captured at the same time, with



the files named appropriately and placed in a common folder. In the example shown below, a series of chemiluminescent image exposures are shown, with the light-field image of the membrane. These images are then overlaid, by making one of the images partially transparent, in order to position the MW markers. Finally, the compound image is cropped to generate the final image for presentation. It is then saved as a single layer JPG (i.e., the information about layers used to make the final image, is removed).



Very importantly, from a forensic perspective, ALL OF THE BACKGROUND NOISE from both layers used to make the final image, is transmitted into the final image combined. Shown on the left, in the top row are the layers generating the compound image, then the final re-saved JPG image with layer information removed.

On the bottom row are the same 4 images with brightness and contrast enhanced to show background noise. Looking at the two images highlighted in the red box, they have numerous overlapping features of background noise, but these two images are of completely different provenance! The one on the left is an overlay of two images, while the one on the right is from a re-saved JPG with no layers.

All of the background noise features from the left image (true overlay) are present in the right image (re-saved no-layers image).

The above series demonstrates that even when images are constructed from compound data collected using a digital gel-doc system, unique features from the background pixelation of each component are carried over into the final image. This series also demonstrates the important principle that background features of a final gel image are unique and should not appear across unrelated experiments. The light-field image of a membrane with MW markers (with its associated noise pattern) should not appear with the chemiluminescent bands originating from another blot membrane. Each set of bands matches to only one background, no more.

Since every image should be unique, when blot images appear to have similar background features but different bands, it is likely that one or more of the component images used to assemble the final compound image has been reused or duplicated. It is possible this can happen due to poor data management, if the component files are named in such a way that leads to confusion. However as mentioned above, best practices call for the acquisition of component images at the same time, and naming/storage in a unique folder hierarchy, to avoid such *mistakes*.

Notably, the likelihood of a series of background features appearing across multiple images is incredibly low, and becomes essentially zero when western blots are separated both by experimental type (origin and naming of samples) and time (whether the experiments were performed months/years apart). The appearance of the same background pixelation across numerous images in a data set is highly indicative of inappropriate image manipulation and would be evidence of misconduct.

2. Forensic analytical methods for western blot images

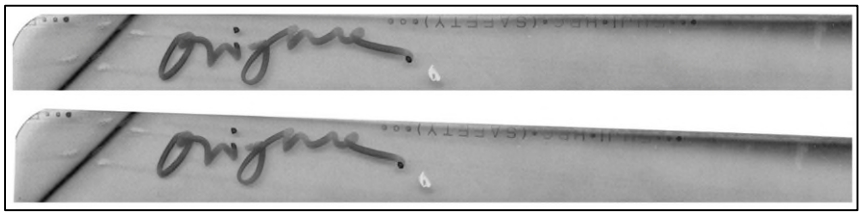
Paul S. Brookes, PhD. University of Rochester Medical Center. October 19th, 2022

Overview

Herein, I will describe standard forensic analytical methods that will be used to analyze western blot figures. Each image is subjected to the following battery of, to highlight features that can aid in determining the origins of the figure or its component parts. This document assumes prior knowledge contained in the introductory paper on western blot preparation and quantitation (the "intro-doc" #1).

1. Magnification to pixel level detail.

To aid in determining whether two images are the same or share a similar origin, magnification is often used to compare a small area of the image at the pixel level. As shown in the example below, these two images of piece(s) of film share numerous similarities (handwriting, text along the top edge, dots in the top left corner, noise in the top right edge) such that, even though one is slightly rotated relative to the other, they are images of the same piece of film



2. Brightness and contrast adjustments, PowerPoint and/or Adobe Photoshop

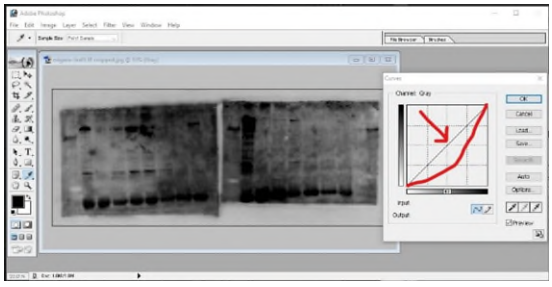
After importing the image into Microsoft PowerPoint (PC, Office 365, version 2207, build 15427.20210), the "Picture Format" menu is used to select the "Corrections" tab, and the contrast, brightness of the image is adjusted. Typically, this involves an increase in contrast of 50-75%, and a decrease in brightness to 30-60% vs. original. Such enhancement often reveals undisclosed seams or borders within an image, indicating where separate parts have been pasted together.

For comparisons between images, PowerPoint is the preferred tool, as it allows multiple images to be compared on a single page, and then annotations can be added to highlight common or different features.

Alternatively, for direct processing of single images (JPG, TIF, etc.), the files can be opened using Adobe Photoshop (PC, version 7.0, 2002), and the Image>Adjustments>Brightness/Contrast menu function is used to adjust the brightness/contrast of the image.

3. Curves function, Photoshop

Another method to adjust brightness/contrast within Photoshop is the "curves" function, under the Image>Adjustments>Curves menu. In a grayscale image, this function allows the user to define the output level for every input level of an image – for example one may wish to enhance dark pixels and to dull bright pixels. The unity line (straight line) leaves an image unaltered (i.e. the output image is the same as the input). The image at left shows a simple curve in red, but more complex curves may be applied, for example to enhance midtones only. Curves may also be applied in a color specific manner if the image has multiple

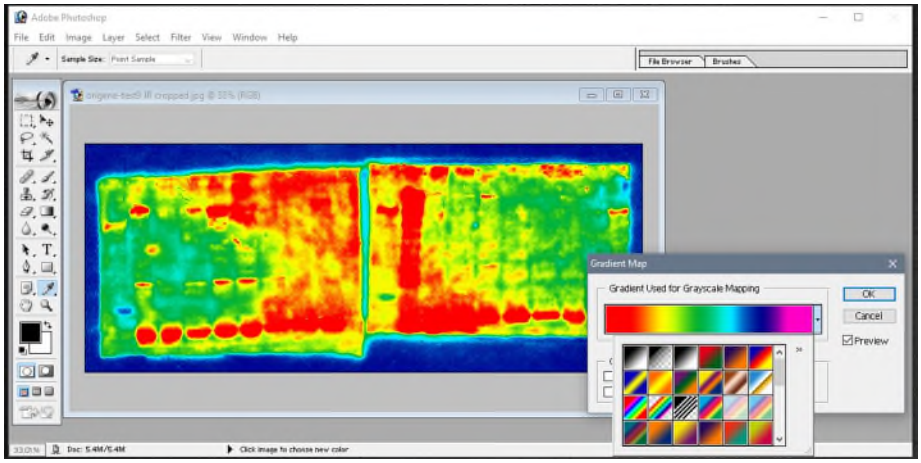


color channels, to enhance pixels of a particular hue (e.g. increase blue, decrease red).

4. Recoloring in PowerPoint or Photoshop.

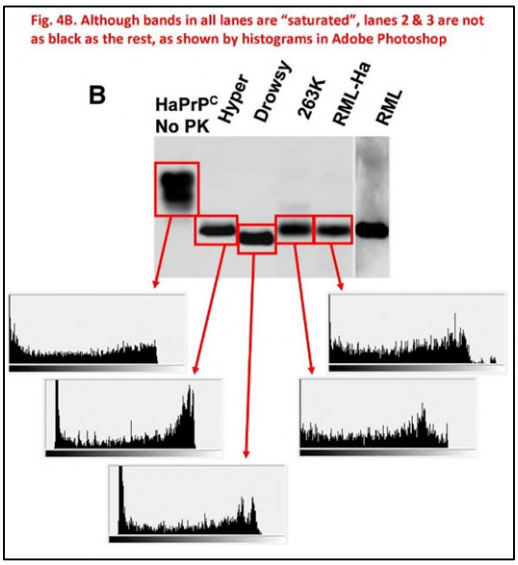
In PowerPoint, in addition to brightness and contrast adjustments, a grayscale image may be recolored, i.e. application of a color mask, and this can help in visualizing similarities/differences between images, as well as highlighting edge features.

In Photoshop, a related feature is the application of a gradient map (accessed via Image>Adjustments>Gradient Map menu feature). Essentially, this feature takes each shade within an image and applies a new color to it, depending on the spectrum chosen from the menu.



5. Histogram analysis, Photoshop

Within a western blot image, the shades available should have similar characteristics, and the range of shades within the image should be similar between similar features. That is, black should be black, white should be white. Sometimes a blot image will appear to have one or more bands where the "blackest black" is not as black as the other black bands. This can sometimes indicate that a band has originated elsewhere and has been pasted into an image with a different overall shading scheme. The histogram function is applied to different areas of an image (e.g. single bands), to show the range of shades used in that area. In the example on the left, some of the bands appear to be black, but are actually very dark gray.



6. JPG Error Analysis, FotoForensics.

The website https://fotoforensics.com/ offers a number of image analysis tools, one of which is ELA or "Error Level Analysis". The JPG image standard includes algorithms to compress the image information, to decrease file size. It is generally understood that within a single JPG image, the entire picture should be at the same compression level. If a section of the image is at a significantly different error level, then it likely indicates this part of the image originated

elsewhere, in an image of different compression level. In the example shown below, the area appearing to originate elsewhere is highlighted by a red arrow.

7. ImageTwin

ImageTwin (https://app.imagetwin.io) is a proprietary image recognition algorithm that is driven by an artificial intelligence engine trained to spot duplications between parts of images in the life sciences. It is not yet commercially available, but I have access to a beta-testing account.

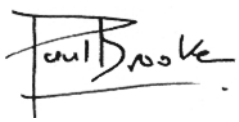
When presented with a paper that contains a large number of images, ImageTwin can look within the paper to determine if any of the components appear duplicated, and then flag them for further analysis. First, the PDF is imported, then parsed to extract images from the Figures, then the Figures are compared. The site also holds a database of all publicly available bioscience images (i.e. PubMed Central) and so can flag whether any of the images in the paper are duplicated from elsewhere in this database.

ImageTwin is more of a screening tool, and would never be used in isolation. Any images flagged by ImageTwin are always further analyzed using the other methods described here, to draw conclusions.

8. Densitometry

Using the gel densitometry feature of ImageJ software, as described in intro.doc, the density of individual bands or lanes on a blot image can be determined, to see if the numbers obtained match those presented alongside blots in graph format. This feature is also useful in determining whether a given set of blots are actually suitable for quantitation by densitometry – many published blots are over-exposed and not suitable for such analysis

Paul S. Brookes, PhD.



3. Analytical pipeline for western blot images

Paul S. Brookes, PhD. University of Rochester Medical Center. October 20th, 2022

Overview

This document describes a 3-stage pipeline that will be applied to the images of interest, using the analytical and forensic image analysis tools previously described (document 2).

Nomenclature - Types of Image Files

Each *analytical triad* consists of 3 related types of image files:

(A) A raw image file. The most basic images (typically JPGs) show a scan of a piece of western blot film, with no further adjustments or annotations.

(B) White box image file. In many cases, a raw image file is accompanied by a partner file with a similar file name, often with the number 11 appended (e.g., image.jpg & image-11.jpg). These images contain white boxes that appear to be superimposed upon the raw film image.

(C) Published image. The final published image is either contained within a Figure of a publication or grant application (usually a PDF file), or in a file where such figures were annotated and prepared for publication (e.g., PowerPoint file).

In certain circumstances, additional and related files may be pulled into the analysis.

Analytical Categories & Stages:

Stage 1. Reverse Analysis

In this stage, the images are analyzed in a reverse (retrograde) manner, from the final published figure (C) back to the raw image (A). The analysis asks two key questions:

Q1. Can the final published image (C) be traced to a white-box image (B) and/or a raw image (A)? The final published image will be compared with the white-box and raw images, to determine if the 3 image files have common features. These features will be used to determine if A and/or B are the source files for C. This analysis focuses mainly on the background noise and other non-data features within each image, rather than bands within the western blots.

Q2. Can the final pattern of bands in the published image (C) be traced to the source images? If it is established that a set of 3 images are related (i.e., A/B are sources for C) then I will ask whether the western blot bands in the final image can be traced to the source images. If the bands in the final image (B) can be traced to the white-box image (B), can those bands in turn be traced to raw image (A)?

Stage 2. Forward Analysis

In this stage, the analysis is performed in the forwards direction, from the raw image (A) and/or white-box image (B) toward the final image (C). The key question (**Q3**) is: **Can the source images be manipulated using accepted techniques, to recreate the final image?** The images in A/B will be adjusted using accepted techniques (i.e., applying

brightness/contrast or other adjustments to the whole image) to determine whether the final image and bands within it can be reproduced.

Stage 3. Further anomalies and notable features

In this stage, I will examine other parts of the 3 images and note any additional unusual features. This includes molecular weight markers, any apparent splicing seams, odd edges, whether final bands match densitometry data presented in the paper/grant, etc.

Documentation and conclusion: Each triad of images will yield a report, outlining answers to the 3 key questions listed above. The following colors will be used to various features between images:

RED: Feature is preserved between images

YELLOW: Feature disappears (is lost) when moving between images

BLUE: Feature appears (is gained) when moving between images

An overall conclusion statement will address whether the pattern of bands in the final published image can find provenance in the source images, and whether the scientific conclusions drawn on the basis of the published image are valid.

In drawing conclusions, the federal definition of scientific misconduct as outlined in 42 CFR § 93.103 will be used: *"Research misconduct means fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results."*

In particular regarding falsification, the following definition from 42 CFR § 93.103 will be used: *"Falsification is manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record."*

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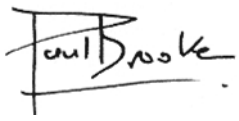
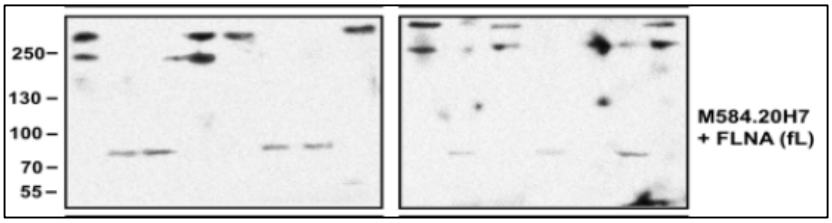


EXHIBIT 5

4.3 Analysis of western blot images in 3rd row of Figure 2 from NIH grant proposal 5R44AG057329-03

Paul S. Brookes, PhD. University of Rochester Medical Center Nov 3rd 2022 (Updated May 2023)

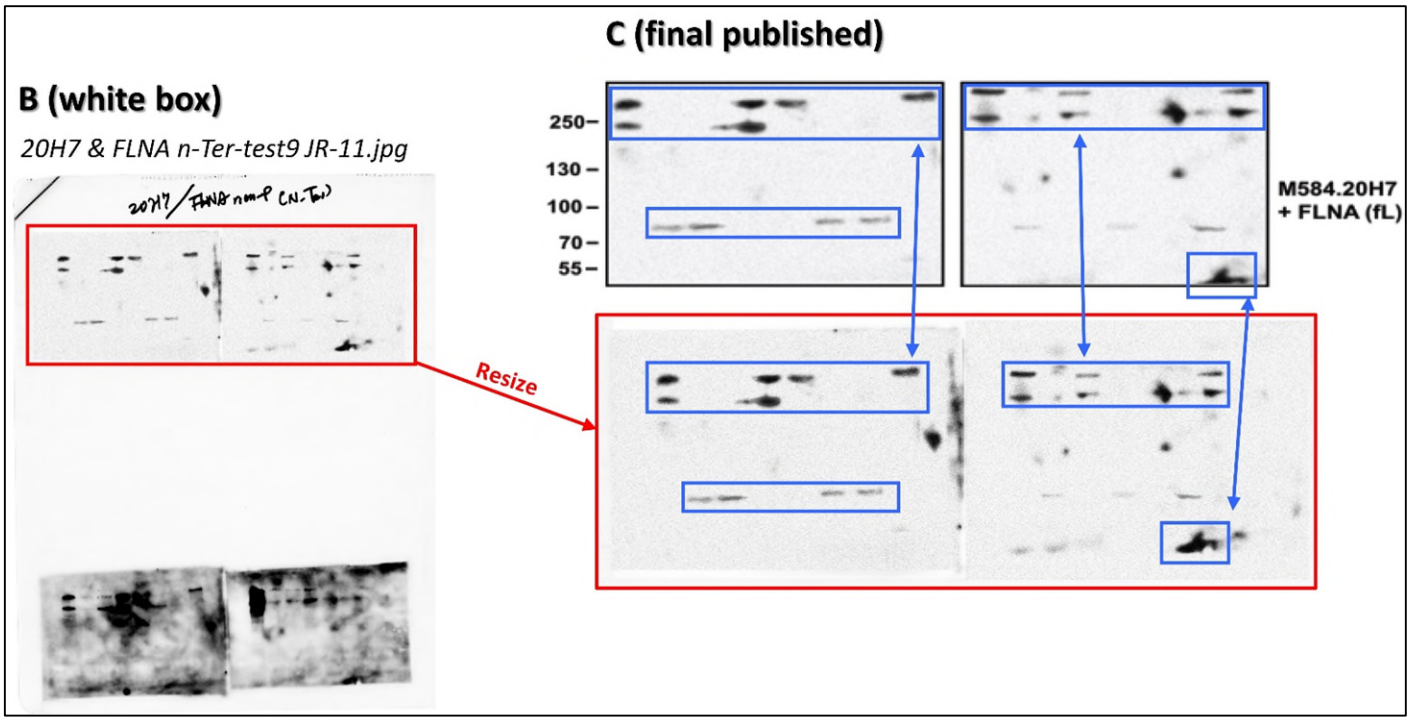
The 3rd row blot from Figure 2 of the proposal is shown here. The layout of blots is similar to the other row: Each lane represents a patient plasma sample, 8 samples in the left panel, 7 in the right. In this case the blots are probed with a mixture of both a custom in-house antibody (M584.20H7) plus an unnamed commercial antibody that reportedly binds to full-length filamin A (FLNA).



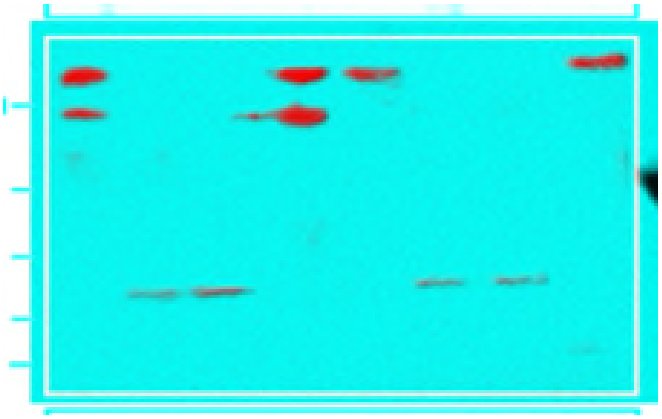
<u>Stage 1.</u> Reverse analysis

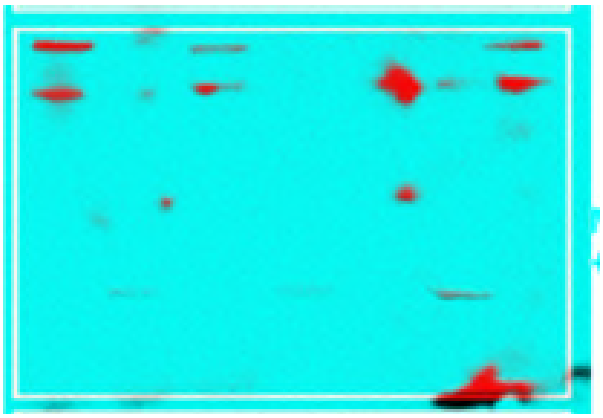
This stage asks the following questions: **Q1.** Can the final published image (C) be traced to a white-box image (B) and/or a raw image (A)? **Q2.** Can the final pattern of bands seen in the published image (C) be traced to the source images?

The file *"20H7 & FLNA n-Ter-test9 JR-11.jpg"* appears to contain an image that is the source for the 3rd row blots in Figure 2. As shown below, numerous features upper portion of this file (outlined in red) map to features in the 3rd row of Figure 2 (highlighted in blue). As such, the bands in the final figure (C) can be traced to the white box image (B).

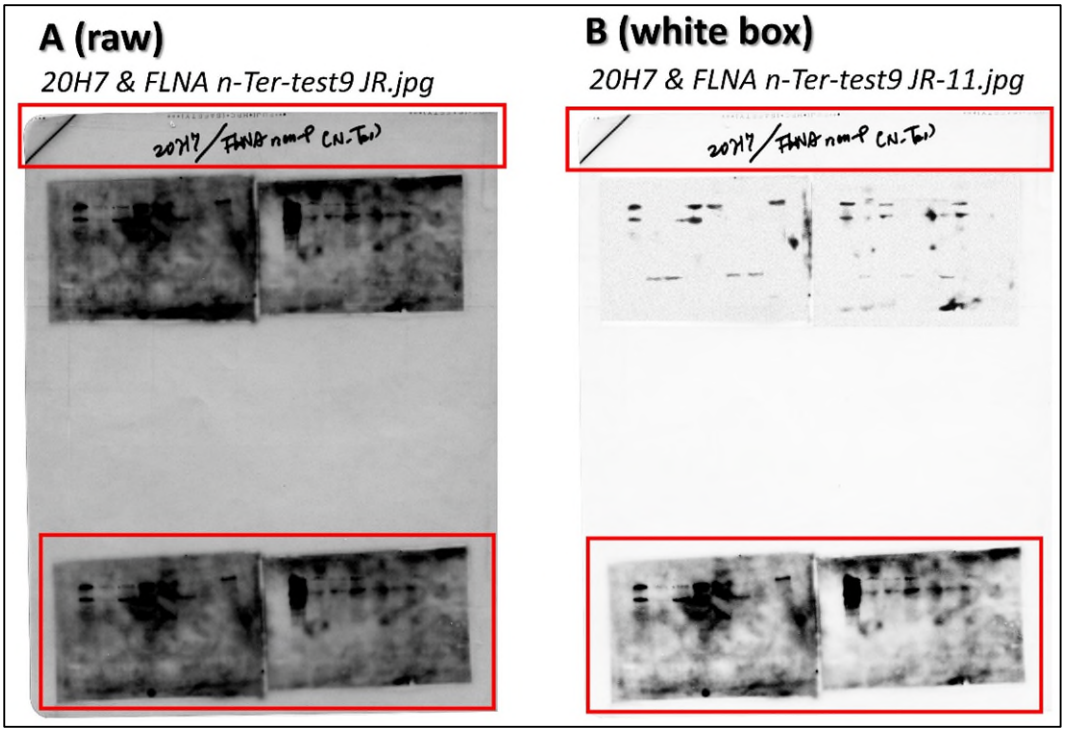


This lineage is confirmed below, with an overlay of the relevant parts of the two images using the ORI *forensic droplets* in Adobe Photoshop (https://ori.hhs.gov/droplets). Each image is pseudo-colored using a gradient map, with the result that overlapping features appear in red.





In addition to *"20H7 & FLNA n-Ter-test9 JR-11.jpg"*, an accompanying file is *"20H7 & FLNA n-Ter-test9 JR.jpg"*, which appears to contain an image of the same piece of film without the white box feature. Note that in this specific example, the image being referred to as "white-box" does not actually have a white box imposed on the raw image. Instead, it appears the whole image has been significantly brightened relative to the raw image. Nevertheless, numerous shared features (highlighted in red) including handwriting at the top, and the blots in the lower portions of the images, allow us to infer that both images were obtained from the same physical piece of film. It is concluded that the raw image (A) and the white-box image (B) share a common origin.



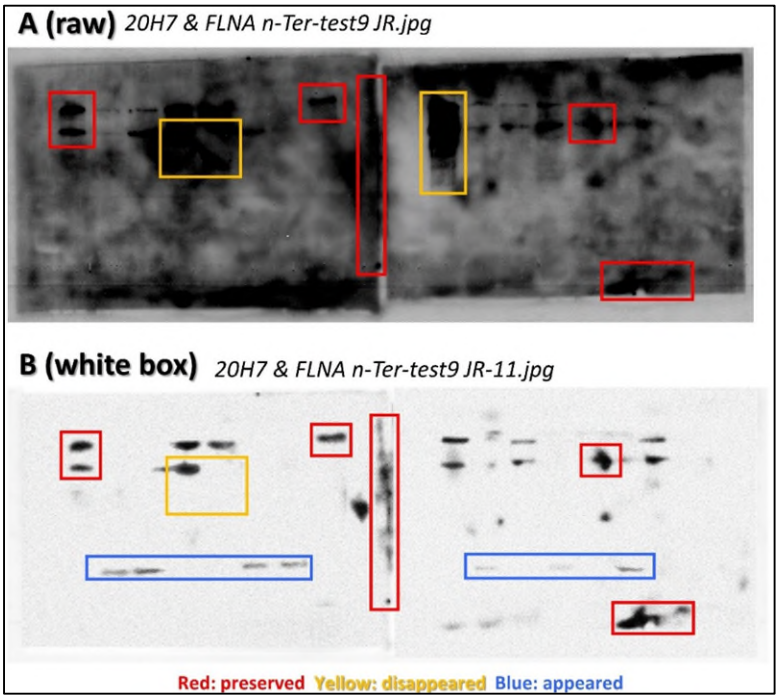
Next, we ask where the white box features in (B) originated? Can any of the bands or other features in the white box image (B) be traced to underlying features in the raw image (A)?

As seen on the next page, some bands and features are preserved between A and B (highlighted red), while others disappear (highlighted yellow), and others appear from nowhere (highlighted blue).

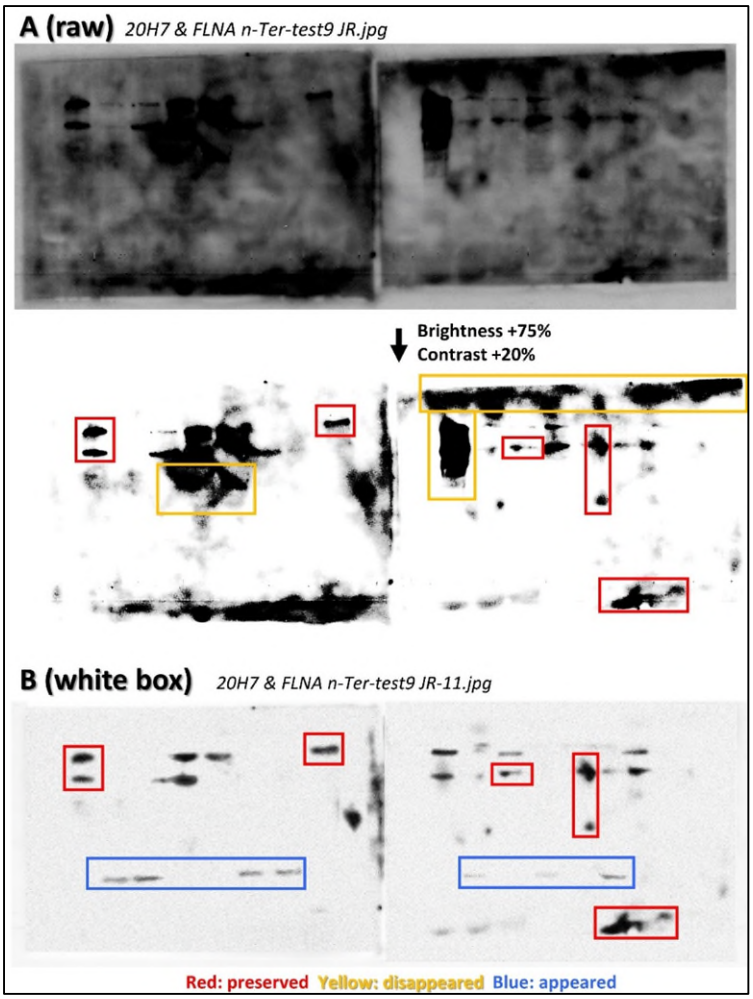
Importantly, all of the bands in the lower part of the image (at the molecular weight allegedly corresponding to the fragment of FLNA, 90 kDa) are nowhere to be seen in the raw image (A). Thus, it is concluded that the pattern of bands seen in the white box image (B), and therefore also in the final published image (C), cannot be traced to any matching features in the raw image (A).

Stage 2. Forward analysis

This stage asks (**Q3**) whether the source images can be manipulated using accepted techniques to recreate the final image? To accomplish this, the raw image (A) *20H7 & FLNA n-Ter-test9 JR.jpg* was subjected to brightness/contrast adjustment, to determine whether features in the white-box image (B) *20H7 & FLNA n-Ter-test9 JR-11.jpg*, could be recreated. This manipulation adhered to the fundamental rule of image processing – any adjustment (contrast, brightness, saturation, color, transparency, etc.) must be applied evenly to the entire field of view. It is unacceptable to adjust selected portions of a blot image such as individual bands.



As shown below, taking the raw image (A) and increasing brightness by 75% and contrast by 20% yields an image with clear bands on a pale background that looks similar to the white-box image (B). There are common features between the adjusted raw image and the white-box image (highlighted red). But, other features have disappeared (yellow), and yet more features have appeared from nowhere (blue).

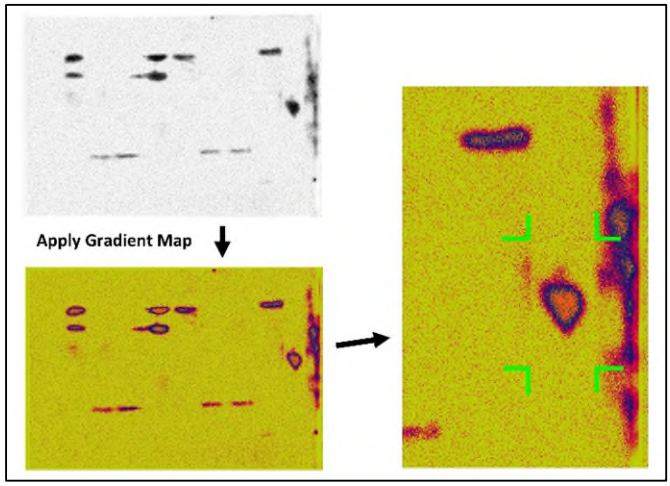


Importantly, many of the "smudges" or other irregularities along the edges of the blot images have been preserved (e.g. the "shark-like" profile in the lower right corner). This further connects the images, indicating a common source.

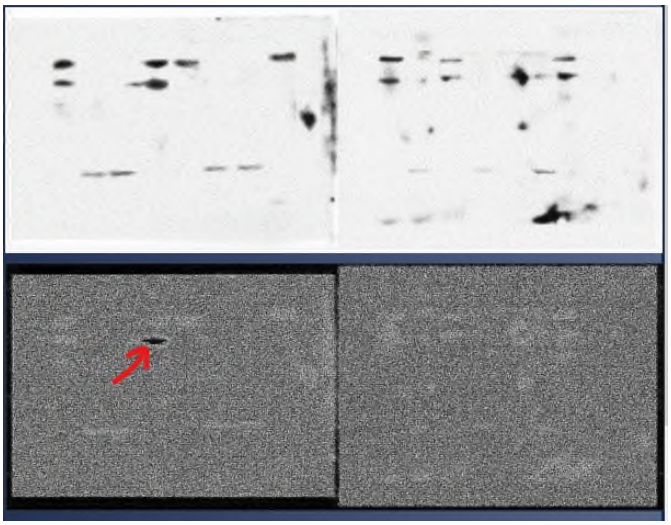
Several potential explanations for the appearance of bands highlighted in blue can be refuted. The box cannot have arisen from digital enhancement of an area in the raw image, because there is essentially no information available to enhance in the corresponding area of the blot. The white box bands cannot have originated from a different exposure of the blot film, since this would result in a separate piece of film, and as already established the raw image and the white box image are the same piece of film. The bands cannot have arisen from digital gel documentation (gel-doc) because the blots were developed using film… to develop using two separate methods (film plus gel-doc) and combine the results is at odds with scientific rationale.

<u>Stage 3.</u> Further anomalies and notable features

Focusing on the right edge of the left-hand blot image in *20H7 & FLNA n-Ter-test9 JR-11.jpg*, application of a gradient map in Adobe Photoshop followed by enlargement of this image reveals a strange box-like feature (corners highlighted in green here on the left ←). The background noise and pixelation inside this box appears to be different to that outside the box. Such sharp changes in background are highly suggestive that part of the image has been pasted in from elsewhere, or that a part of the image has been selected and independently adjusted. This suggests inappropriate manipulation.



Furthermore, application of a JPG Error Level Analysis (ELA) from the website https://fotoforensics.com/ to the white box image (B) *20H7 & FLNA n-Ter-test9 JR-11.jpg* is shown here (← original on top, ELA below). It is generally understood that all parts of a JPG image should be at roughly the same compression and error level. If a section of an image has a significantly different error level, this can indicate it may have originated elsewhere.



ELA reveals that one of the bands in the left-hand blot contains significantly different JPG compression and error information, compared to the rest of the image (this is indicated by the black band annotated with a red arrow). This is highly suggestive that this band has been added from a source image with a different JPG compression level, or this part of the image has been independently manipulated relative to the remainder of the image.

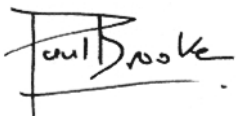
Furthermore, despite the appearance of molecular weight (MW) markers in the final figure, none of the original images contain any information on MW. There are no MW ladders or markings on the film. As such, the origin of the MW marker assignments in the final figure is unclear. Finally, it is notable that both the raw image (A) and white-box image (B) appear to contain smudges, stains, botches, streaks and other undesirable features within the blot images. These are generally indicative of poor-quality western blots, poor experimental practices, or lack of specificity of the antibody being used.

PowerPoint Intermediate File

The .PPT file *"Origene-20H20-20H7+FLNA NT-JR9 test.pptx"* contains the complete Figure 2 in annotated form, with each of the original images noted above pasted into place and matching the final image. The modification date for this file (2019-10-02) is in between the dates of the JPG images (2019-10-01) and the submission of the grant application (2019-11-18).

Summary & Conclusion.

Based on the above evidence, I conclude that the source of the final image (C) in the 3rd row of Figure 2 of the grant proposal is the white box image (B) "*20H7 & FLNA n-Ter-test9 JR-11.jpg*". Although this image and its corresponding raw image (A) "*20H7 & FLNA n-Ter-test9 JR.jpg*" share several common features, application of acceptable image manipulation processes to the raw image was unable to reproduce the bands in the white box image. As such, the band pattern in the final published image finds no provenance in the source images. In the absence of original blot images showing the bands of interest as they appear in the final figure, it is my professional opinion that the final figure and its parent white box image and band pattern have been fabricated. As per the federal definition of scientific misconduct, the presented data do not appear to accurately represent the research record.



Paul S. Brookes, PhD.

EXHIBIT 6

Curriculum Vitae

Ernest P. Chiodo, M.D., J.D., M.P.H., M.S., M.B.A., C.I.H.

Diplomate of the American Board of Internal Medicine
Diplomate of the American Board of Preventive Medicine in Occupational Medicine
Diplomate of the American Board of Preventive Medicine in Public Health and General Preventive Medicine
Diplomate of the American Board of Industrial Hygiene as a Certified Industrial Hygienist
Graduate Biomedical Engineer
Graduate Toxicologist

PROFESSIONAL ADDRESSES:

Detroit Area:	Chicago:	Palm Beach, Florida:
Ernest Chiodo P.C. 35770 Harper Avenue Clinton Township, Michigan 48035 Tel: (586) 746-1761	Ernest Chiodo P.C. 221 N. LaSalle Street Suite 854 Chicago, IL 60601 Tel. (312) 351-0717	701 S. Olive Suite 113 W. Palm Beach, FL 33401 Tel. (561) 603-7701

Email: epchiodo@gmail.com
www.ernestpchiodo.com

EDUCATION:

University of Oxford
Master of Science in Nanotechnology for Medicine and Health Care
December 19, 2022 (Ceremony November 3, 2023)

University of Oxford
Master of Science in Experimental and Translational Therapeutics
April 7, 2021 (Ceremony May 14, 2022)

University of Oxford
Master of Science in Evidence-Based Health Care
November 2, 2018

University of Chicago
Master of Business Administration
with a Concentration in Economics
December 9, 2011

Wayne State University
Master of Science in Occupational and Environmental Health Sciences
with Specialization in Industrial Toxicology
December 23, 2009

University of Chicago
Master of Science in Threat Response Management
(Scientific tract in biological, chemical, and radiological defense)
June 12, 2009

Wayne State University Department of Biomedical Engineering
College of Engineering and School of Medicine
Master of Science in Biomedical Engineering
December 20, 2007

Harvard University School of Public Health
Master of Public Health
June 8, 1989

Wayne State University Law School
Juris Doctor
June 14, 1986

Wayne State University School of Medicine
Doctor of Medicine
June 8, 1983

Kalamazoo College
Bachelor of Arts
June 14, 1980
Due to high academic achievement, accepted into medical school one year early so that the freshman year of medical school at Wayne State University School of Medicine was counted as credit for the senior year of college by Kalamazoo College (3:1 Program).

SPECIALTY TRAINING:

Mini Residency in German Social Medicine at the
Landesversicherungsanstalt Baden in Karlsruhe, Germany
May 1992

Resident Physician in Internal Medicine
Providence Hospital
Southfield, Michigan
July 1, 1989 to June 30, 1992

Resident Physician in Diagnostic Radiology
Detroit Medical Center
Detroit, Michigan
July 1, 1983 to June 30, 1985

PROFESSIONAL ACTIVITY:

Ernest Chiodo P.C.
Professional corporation licensed to practice medicine and law
in the State of Michigan. and Illinois
1989-Present

Medical professional activities through Ernest Chiodo P.C. have included acting as the Chief Medical Director of the Visiting Nurse Association of Southeastern Michigan; Medical Director of the City of Lansing Police and Fire Pension Board; Medical Director of the City of Lansing General Employee Retirement System; Medical Director of the Fire and Police Pension System of the Charter Township of Clinton, Michigan; International Advisor on Bird Flu to Goodrich Corporation (Formerly B.F. Goodrich); the clinical practice of internal medicine; the clinical practice of preventive medicine; the practice of occupational and environmental medicine; the practice of occupational, environmental, and industrial toxicology; the practice of industrial hygiene; biomedical engineering; and biostatistics and epidemiology. Legal professional activities have included the practice of toxic tort law as well as the practice of health care law in the representation of physicians, nurses, and other health care professionals. Areas of representation have included licensure and peer review issues; contract review and negotiation; Stark Amendments; Sherman and Clayton Anti-trust Acts; new medical technology assessment; and co-counsel activities in medical malpractice defense. Health care law activities have included consultation and general counsel activities for health care entities including service as legal counsel to the Medical Staff and Internal Medicine Department of Henry Ford Bi-County Hospital. Biomedical engineering activities include determination of causation of disease in relation to claimed physical forces and energy. Health care economics activity has included analysis of reasonableness of charges for medical devices and services.

Center for Health Outcomes and Evaluations
Michigan Peer Review Organization
Clinical Coordinator
1995-1996

The activities for the Center for Health Outcomes and Evaluations, a division of the Michigan Peer Review Organization, involved conducting clinical outcomes research. This research was

contracted for by the Health Care Financing Administration. The research compared clinical outcomes in hospitals throughout the State of Michigan. The information gained through the research was also presented to collaborating hospitals and their medical staffs in an effort to increase quality of care for Medicare beneficiaries.

Medical Director and Manager of Medical and Public Health Services
City of Detroit
1993-1995

Service as the Medical Director and Manager of Medical and Public Health Services provided by the City of Detroit to over one million persons living and working in the City of Detroit and over 4.5 million persons drinking City of Detroit water with supervision of over 1,200 professionals working in the Detroit Health Department including physicians, dentists, nurses, pharmacists, radiology technicians, substance abuse professionals, industrial hygienists, epidemiologists, biostatisticians, clinical and public health laboratory technicians, building inspectors, lead inspectors, lead treatment professionals, social hygienists, and food sanitarians. This was a position of substantial public responsibility serving as advisor to the Mayor of the City of Detroit on medical and public health issues as well as having the direct telephone number to the United States White House in the event that the President needed to be contacted due to a public health emergency or disaster in the City of Detroit.

Medical Director
House Physician Program
Bi-County Community Hospital
1992-1993

Medical Director of the physicians servicing the medical needs of patients admitted to the non-teaching service of Bi-County Community Hospital.

Medical Director and Chief Executive Officer
General Health Corporation
1985-1989

Home health care service caring for serious traumatically brain injured and quadriplegic patients.

PROFESSIONAL LICENSURE:

Physician and Surgeon
Michigan, Illinois, Florida and New York

Attorney and Counselor
Michigan and Illinois

TRADE LICENSURE:

Residential Builder
Michigan

SPECIALTY BOARD CERTIFICATION:

Diplomate of the American Board of Internal Medicine
(First recertification May 2000)
(Second recertification November 2012)
(Third recertification November 2020)

Diplomate of the American Board of Preventive Medicine in Occupational Medicine

Diplomate of the American Board of Preventive Medicine in Public Health and General Preventive Medicine

Diplomate of the American Board of Industrial Hygiene as a Certified Industrial Hygienist

MEDIATION CERTIFICATION:

Completion of requirements of Michigan Court Rule 2.411 to serve as a court appointed mediator in Michigan.

MEDICAL REVIEW OFFICER CERTIFICATION:

Medical Review Officer Certification through the Medical Review Officer Certification Council.

RATINGS

BV Rating by Martindale-Hubbell Ratings

"A BV Rating is an indication of an exemplary reputation and well-established practice. A typical lawyer is in mid-career, with a significant client base and high professional standing."

"CV, BV and AV are registered certification marks of Reed Elsevier Properties Inc., used in accordance with the Martindale-Hubble certification procedures, standards and policies."

PROFESSORSHIPS AND FACULTY APPOINTMENTS:

Assistant Clinical Professor of Internal Medicine, Family Medicine and Public Health
Wayne State University School of Medicine
Detroit, Michigan
1994-2013

Adjunction Assistant Professor of Industrial Hygiene and Industrial Toxicology
Eugene Applebaum College of Pharmacy and Health Science
Department of Occupational and Environmental Health Sciences
Wayne State University
Detroit, Michigan
2009-2013

Adjunct Professor of Law
John Marshall Law School
Chicago, Illinois
(2009 to 2016)

Adjunct Professor of Law
Loyola University of Chicago Law School
Chicago, Illinois
(2011 to 2016)

FELLOWSHIPS:

Royal Society of Medicine
Overseas Fellow
Elected 2000

PROFESSIONAL ORGANIZATIONS:

State Bar of Michigan
Environmental Law Section of the State Bar of Michigan
Royal Society of Medicine (U.K.)
American Industrial Hygiene Association
American Conference of Governmental Industrial Hygienists
University of Chicago Booth Health Care and Biopharma Round Table. Co-Chairperson.
Florida Medical Association
Full Member Society of Toxicology
Society of Automotive Engineers
Wayne State University Medical Alumni Association Board (2022-2025)
Oakland County Michigan Bar Association.
Medical/Legal Committee of the Oakland County Michigan Bar Association
Detroit Bar Association
Macomb County Michigan Bar Association

PROFESSIONAL ORGANIZATION LEADERSHIP:

Vice Chairman, By-laws Committee: Wayne County Medical Society 1994-1995
Chairman, By-laws Committee: Harper Hospital 1995-1997
Member, Public Health Committee: Wayne County Medical Society 1993-1996
Member, Medical-Legal Committee: Wayne County Medical Society 1994-1996
Member, Michigan Department of Public Health Liaison Committee: Michigan State Medical Society 1994-1996
Chief Medical Director: Visiting Nurse Association of Southeastern Michigan 1994-1999, 2002-2005.
Medical Director Emeritus: Visiting Nurse Association of Southeastern Michigan 2005-Present
Member, By-laws Committee: Henry Ford Bi-County Hospital 2004 -2010
Member, Infection Control Committee: Henry Ford Bi-County Hospital 2003-2010
Vice Chairman and Chairman of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan. 2006-2012.
Council Member of the Environmental Law Section of the State Bar of Michigan (The Council is the governing body responsible for general supervision and control of the affairs of the Section). 2006 –2012
Board of Directors of the Michigan Industrial Hygiene Society 2006-2007.
President-Elect of the Michigan Industrial Hygiene Society 2007.
President of the Michigan Industrial Hygiene Society 2008.
Co-Chairman of the University of Chicago Booth Health Care and Biopharma Round Table. 2012 to Present.
Member of Board of Directors of the University of Chicago Booth Alumni Club 2012-2013.
Legal advisor to Workplace Health Without Borders. 2015 –Present.

COMMUNITY SERVICE ORGANIZATION LEADERSHIP:

Michigan Cancer Foundation Board of Trustees (Term 1994-1997)
Tri-cities Tobacco Action Coalition Advisory Board 1994-1995
Tobacco Free Michigan Active Doctors Advisory Committee 1994-1995
Wayne County American Cancer Society Board of Directors 1994-1996

SOCIAL AND ALUMNI ORGANIZATIONS:

University Club of Chicago
Harvard Club of New York City
University of Chicago Booth Health Care and Biopharma Roundtable
Oxford Union
The Prismatic Club of Detroit
Oxford and Cambridge Club (London)
Wayne State University School of Medicine Alumni Association Board of Governors (Term 2022-2025)

RESEARCH:

Stitch Entrapment of Swan-Ganz Catheter during Cardiac Surgery. Presented at the American College of Physicians Associates Meeting, May 11, 1990 and the Michigan Chapter Meeting, Traverse City, Michigan, October 11-14, 1990.

Altered Cerebral Dominance in an Atopic Population. Presented at the American College of Physicians Associates Meeting, May 11, 1990 and orally presented at the Michigan Chapter Meeting, Traverse City, Michigan, October 11-14, 1990.

Code Status Determination: An Analysis of Decisions by Health Care Professionals. Orally Presented at the American College of Physicians Associates Meeting, May 10, 1991.

A Case of Ovarian Carcinoma with Concomitant Weakness and Dysphagia and Biopsy Proven Myositis. Presented at the American College of Physicians Associates Meeting, May 10, 1991 and the Michigan Chapter Meeting, Traverse City, Michigan. September 26-28, 1991.

A Case of Persistent Hyponatremia in a Patient with a Mediastinal Mass on CT. Presented at the American College of Physicians Associates Meeting, May 10, 1991 and the Michigan Chapter Meeting, Traverse City, Michigan, September 26-28, 1991.

Refractory Pneumocystis Carini Pneumonia in a HIV Positive Patient Successfully Treated with 566c80 a 1,4 Hydroxynapthoquinone with a Broad Spectrum Antiprotozoal Activity. Presented at the American College of Physicians Associates Meeting, Dearborn, Michigan, May 1992.

PRESENTATIONS AND LECTURES:

Health Care Regulations in Present Day Medical Practice. Presented as part of the Current Problems in Medicine 1990 course sponsored by St. John Hospital and Medical Center. Hyatt Regency, Dearborn, Michigan on October 21, 1990. Approved for 4.5 hours category 1-CME credit.

The Medical, Legal, and Financial Consequences for Catastrophic Injury. Presented at the Eastern Michigan Area Social Security Manager's Meeting at the request of the Department of Health & Human Services. Pontiac, Michigan on June 11, 1990.

Advisor and judge of the 1st Annual Wayne State University School of Medicine - Wayne State University Law School Mock Medical Malpractice Trial . Sponsored by the American Medical Association and approved for law school credit. Gordon Scott Hall, Wayne State University School of Medicine, February 27, 1991.

Advisor and judge of the 2nd Annual Wayne State University School of Medicine - Wayne State University Law School Mock Medical Malpractice Trial). February 25, 1992.

Krankenversicherung in die Vereinigten Staaten (Health Insurance in the United States). Lecture given in German to the physicians of the medical division of the Landesversicherungsanstalt Baden in Karlesruhe, Germany, May 12, 1992. The Landesversicherungsanstalt is the German equivalent of the Social Security Administration.

Privatization of Government. Panel discussion given at the Michigan Association of Counties meeting at the Grand Hotel on Mackinaw Island, Michigan on August 20, 1993. My portion of the discussion focused on the arguments for and against privatization of public health services at the county and municipal level.

Law for the Industrial Hygienist. Lecture given in the Department of Occupational and Environmental Health in the School of Allied Health and Pharmacy, Wayne State University on November 30, 1993.

Teen Pregnancy, Sex, and Health Care. Workshop presented at the Youth Anti-Crime Summit: A Blueprint for Our Future. Wayne County Community College in Detroit, Michigan on October 23, 1993.

The Obstetrician and Gynecologist as a Primary Care Physician. Grand Rounds presented to the staff of Hutzel Hospital and the Department of Obstetrics and Gynecology of Wayne State University School of Medicine. February 8, 1994 at Hutzel Hospital in Detroit, Michigan.

Breast and Cervical Screening: What the Pharmacist Needs to Know. Lecture presented at the 1994 interim meeting of the Michigan Pharmacists Association at the Hyatt Regency in Dearborn, Michigan on February 18, 1994.

Career Opportunities in Health Care Law. Panel discussion with Edward B. Goldman, Medical Center Attorney for the University of Michigan, and Bettye S. Elkins, health care attorney with the firm of Dykema Gossett, presented to the Health Care Law Society of the University of Michigan Law School. March 9, 1994 in Hutchins Hall, University of Michigan Law School.

Community Health Grand Rounds. Member of panel discussion presented at the Detroit Health Department. Sponsored by the Southeastern Michigan Health Association and the Resource for Public Health Policy of the University of Michigan School of Public Health. March 10, 1994.

Environmental Toxicology. General Internal Medicine Ambulatory Grand Rounds. Wayne State University School of Medicine. March 18, 1994 in the Morse Auditorium of Harper Hospital.

Introduction to Occupational and Environmental Medicine. Internal Medicine Grand Rounds. March 22, 1994. St. John Hospital and Medical Center. Detroit, Michigan.

What the Family Practitioner Should Know About the National Practitioner Data Bank. Presented to the Department of Family Practice. April 1, 1994. St. John Hospital and Medical Center. Detroit, Michigan.

Public Health Case Studies. Presented to the University of Michigan Family Practice Residency Program. April 6, 1994. University of Michigan Chelsea Family Practice Center. Chelsea, Michigan.

Teen Pregnancy: A fresh approach to an old problem. Sponsored by the Wayne State University School of Medicine, the Wayne County Medical Society, and the March of Dimes Birth Defects Foundation, Southeastern Michigan Chapter. Approved for 3.5 continuing medical education credit hours in category 1. Presentation of the public health considerations in the session entitled Contraception versus Abstinence. April 27, 1994. Wayne County Medical Society Building. Detroit, Michigan.

The Future of the American Health Care System. Presented to the German-American Business Network. Sponsored by the German Consulate in Detroit. May 5, 1994. Hyatt Regency. Dearborn, Michigan.

The Future of Health Care in Detroit. Presented at the Henry Ford Health System Planning and Strategic Development Division Retreat. May 9, 1994. 1 Ford Place. Detroit, Michigan.

Was Napoleon Murdered by Arsenic Poisoning? Presented to the Napoleonic Society of America. September 16, 1994. Union League Club. Chicago, Illinois.

Is the World Safe for Children?: Environmental hazards and Their Impact. Presented at the Third Annual Medstart Conference. University of Michigan Medical School. January 21, 1995. Townsley Center. Ann Arbor, Michigan.

Treatment and Management of Arthritis in the Workplace. Presented at the Wayne County Medical Society conference on Arthritis in the Workplace. Co-sponsored for CME credits by the Medical and Public Health Issues Committee of the Wayne County Medical Society and the American College of Occupational and Environmental Medicine. January 28, 1995. Wayne County Medical Society Building. Detroit, Michigan.

Law and Medicine: What they didn't teach you in medical school. Presented for ambulatory grand rounds at the Veteran's Administration Medical Center in Allen Park, Michigan. April 25, 1995. Also presented to the following groups: Henry Ford Hospital Department of Urology. Henry Ford Hospital in Detroit, Michigan. June 14, 1995. Pediatric Grand Rounds. Children's Hospital of Michigan in Detroit, Michigan. August 25, 1995. Department of Physical Medicine and Rehabilitation. William Beaumont Hospital in Royal Oak, Michigan. September 15, 1995. Internal Medicine Grand Rounds. Grace Hospital in Detroit, Michigan. September 21, 1995. Wayne State University School of Medicine Department of Otorhinolaryngology. Harper Hospital in Detroit, Michigan. September 23, 1995. University of Michigan School of Medicine Department of Physical Medicine and Rehabilitation. University of Michigan Hospital in Ann Arbor, Michigan. September 28, 1995. Wayne State University School of Medicine Department of Neurology. Harper Hospital in Detroit, Michigan. October 6, 1995. Department of Obstetrics and Gynecology Grand Rounds. St. Joseph Mercy Hospital. Ann Arbor, Michigan. October 19, 1995. Department of Obstetrics and Gynecology Grand Rounds. University of Michigan Hospital. Ann Arbor, Michigan. Department of Ophthalmology. University of Michigan School of Medicine. Ann Arbor, Michigan. December 20, 1995. Department of Ophthalmology Grand Rounds, Henry Ford Hospital in Detroit, Michigan. February 16, 1996. Department of Surgery Grand Rounds. St. Joseph Mercy Hospital. Ann Arbor, Michigan. February 27, 1996. Michigan Association of Physicians from India. Dearborn Inn. Dearborn, Michigan. March 20, 1996. Wayne State University School of Medicine Department of Surgery Grand Rounds, Harper Hospital. Detroit, Michigan. May 4, 1996. Wayne State University School of Medicine Department of Internal Medicine. Grace Hospital. Detroit, Michigan. April 4, 1997. Wayne State University School of Medicine. Gordon Scott Hall. Detroit, Michigan. April 15, 1997. Michigan Psychiatric Society. Sheraton Inn. Ann Arbor, Michigan. April 24, 1997. Calhoun County Medical Society. Cedar Crest Banquet Center. Marshall, Michigan . February 13, 2001. Department of Family Practice Division of Occupational Medicine. Wayne State University School of Medicine. Detroit, Michigan. February 22, 2001. Department of Family Practice Division of Occupational Medicine. Wayne State University School of Medicine. Detroit, Michigan. August 15, 2001 St. John Hospital and Medical Center Department of Family Practice. St. Clair Shores, Michigan. October 23, 2001. Bon Secours Cottage Health Services. Henry Ford Health System. Grosse Pointe, Michigan. No-

vember 13, 2001. Department of Family Practice Division of Occupational Medicine. Wayne State University School of Medicine. Detroit, Michigan. November 14, 2001. Department of Psychiatry Grand Rounds. Henry Ford Health System. One Ford Place. Detroit, Michigan. November 15, 2001. Department of Pediatrics Grand Rounds. Henry Ford Health System. Henry Ford Hospital. Detroit, Michigan. December 13, 2001. Department of Surgery. Providence Hospital. Southfield, Michigan. February 14, 2002. Department of Family Practice Division of Occupational Medicine. Wayne State University School of Medicine. Detroit, Michigan. February 18, 2002. Pediatrics Residents. Henry Ford Health System. Henry Ford Hospital. Detroit, Michigan. May 3, 2002. Psychiatry Residents. Henry Ford Health System. One Ford Place. Detroit, Michigan. November 21, 2002. Psychiatry Residents. Henry Ford Health System. One Ford Place. Detroit, Michigan. January 15, 2004. Henry Ford Hospital Department of Cardiology. Detroit, Michigan. December 6, 2004. Harper Hospital Department of Cardiology. Detroit, Michigan. December 20, 2004. Southeastern Michigan Cardiology Fellows Club. Shula's Restaurant. Marriott Hotel. Troy, Michigan. November 16, 2005. Wayne State University School of Medicine. Gordon Scott Hall. Detroit, Michigan. January 24, 2006. Department of Dermatology, Wayne State University School of Medicine. VA Medical Center, Detroit, Michigan. January 17, 2007. Cardiology Fellows. William Beaumont Hospital. Royal Oak, Michigan. February 6, 2007. Residents and Medical Students. Henry Ford Bi-County Hospital. April 30, 2007. Medical Staff of William Beaumont Hospital Grosse Pointe. Grosse Pointe, Michigan. January 17, 2008. Department of Occupational and Environmental Medicine. University of Illinois at Chicago. Chicago, Illinois. May 7, 2008. Cardiology Fellows. William Beaumont Hospital. Royal Oak, Michigan. May 15, 2008. Cardiology Fellows. William Beaumont Hospital. Royal Oak, Michigan. June 2, 2009.

Euthanasia: Lessons from the past. Department of Internal Medicine Ambulatory Grand Rounds. Wayne State University School of Medicine. Harper Hospital. Detroit, Michigan. November 14, 1995. Also presented to the Department of Internal Medicine. Veteran Administration Medical Center. Allen Park, Michigan. March 19, 1996.

Legal Issues of Concern to Pharmaceutical Representatives. Detroit Pharmaceutical Representative Association. Southfield, Michigan. December 1, 1995.

The Future of American Health Care: A crystal Ball. Presented at Wayne State University School of Medicine for Primary Care Week. Gordon Scott Hall. Detroit, Michigan. September 27, 1995. Also presented to the following groups: Department of Ophthalmology Grand Rounds. Henry Ford Hospital. Detroit, Michigan. February 16, 1996. Glaxo-Wellcome Michigan Representatives Meeting. Ann Arbor, Michigan. March 27, 1996. Wayne State University School of Medicine. Gordon Scott Hall. Detroit, Michigan. February 14, 1997.

Elderly Law: A primer for Health Care Professionals. Presented to the Department of Geriatrics, Henry Ford Hospital. Detroit, Michigan. October 5, 1995.

An Ethical Dilemma: Informed Consent. Harper Hospital. Detroit, Michigan. February 28, 1996.

Violence in the Workplace. Walsh College. Troy, Michigan. March 8, 1996.

Law and Medicine: What they didn't teach you in Medical School-Part II. Department of Internal Medicine. Business Series for Residents. St. John Hospital and Medical Center. Detroit, Michigan. May 23, 1997.

Expert Testimony in Environmental Litigation. Presented for the Institute of Continuing Legal Education at the Michigan Environmental Planning and Litigation Update. MSU Management Education Center. Troy, Michigan. July 16, 1998.

Florida Laws and Rules
Michigan Osteopathic Association 101st Annual Postgraduate Convention & Scientific Seminar. Hyatt Regency Dearborn, Michigan. Saturday, May 20, 2000.

Lungs and the Listings
National Organization of Social Security Claimants' Representatives. Social Security Disability Law Conference Annual Spring Conference. Hilton at Walt Disney World Village. Lake Buena Vista, Florida. May 4, 2000.

Worker's Compensation for Occupational Medicine Physicians
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Gordon Scott Hall
Detroit Michigan. May 25, 2000.

Lungs and the Listings
State Bar of Michigan
Social Security Section Seminar
Park Place Hotel
Traverse City, Michigan. July 28, 2000.

Interesting War Stories from the Worlds of Medicine, Law and Actuarial Analysis
Michigan Actuarial Society
Hilton Inn
Southfield, Michigan. September 11, 2000.

Statistics in Environmental Litigation.
Environmental Litigation Committee
Environmental Law Section
State Bar of Michigan
Michigan National Tower. Lansing, Michigan February 17, 2001.

Worker's Compensation for Occupational Medicine Physicians
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 22, 2001.

Florida Laws and Rules
Michigan Osteopathic Association 102nd Annual Postgraduate Convention & Scientific Seminar.
Hyatt Regency Dearborn, Michigan. Saturday, May 12, 2001.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 16, 2001.

Genetic Evidence in Paternity Cases: What the Lawyer Must Know
Presented by the Domestic Relations Committee of the Macomb County Bar Association
5th Floor Jury Room
Macomb County Court Building
Mount Clemens, Michigan June 4, 2001

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 15, 2001.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 18, 2002.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 23, 2002.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 5, 2002.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. November 11, 2002.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 3, 2003.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 4, 2003.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 4, 2003.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 9, 2004.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 10, 2004.

Legal Issues for the Intern. Intern Orientation. Henry Ford Bi-county Hospital. June 16, 2004. Warren, Michigan.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 16, 2004.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 14, 2005.

Winning the Sick Building Case.
Michigan Trial Lawyers Association.
Shanty Creek Resort. Bellaire, Michigan. February 11, 2005.

The Second Most Important Lecture of Your Career. Michigan Chapter of the American College of Cardiology. William Beaumont Hospital Heart Center. Royal Oak, Michigan April 20, 2005.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 9, 2005.

Medical and Legal Considerations for the Occupational Medicine Physician.
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. July 15, 2005.

What the Occupational Medicine Physician Should Know about Toxic Tort Law.
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. July 22, 2005.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. November 7, 2005.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 6, 2006.

Radium City Town Hall Meeting
Panel participation
Occupational and Environmental Health (CM) 7860
Applebaum Hall
Wayne State University School of Pharmacy and Allied Health
Detroit, Michigan. February 1, 2006

Worker's Compensation Law and the Americans with Disabilities Act
Occupational and Environmental Health (CM) 7860
Applebaum Hall
Wayne State University School of Pharmacy and Allied Health
Detroit, Michigan. February 22, 2006

Proving and Disproving Causation in Environmental Litigation
Panel Participation
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan
Presented at the office of Ernest Chiodo P.C. Clinton Township, Michigan. February 23, 2006.

Interesting Answers to Complex Disability Problems.
Michigan Safety Conference.
Lansing Center, Lansing, Michigan April 18, 2006.

Legal Consideration in Medical Specialty Selection
Wayne State University School of Medicine –American Medical Association Student Chapter.
Wayne State University School of Medicine. Gordon Scott Hall. Detroit, Michigan. April 21, 2006.

Mold: State of the Law and Science
Joint Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan and the Michigan Industrial Hygiene Society.
Presented at the office of Ernest Chiodo P.C. Clinton Township, Michigan. May 1, 2006.

Case Studies in Forensic Medicine
Consulting Physicians P.C. Spring 2006 Medical Education Seminar
Holiday Inn South Convention Center. Lansing, Michigan May 3, 2006.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 8, 2006.

Toxic Exposure
GM National Benefits Center
Southfield, Michigan. June 12, 2006

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 14, 2006.

Carbon Monoxide: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan.
Presented at the office of Ernest Chiodo P.C. Clinton Township, Michigan. September 20, 2006.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. November 6, 2006.

Metal Working Fluids: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan.
Presented at the office of Ernest Chiodo P.C. Clinton Township, Michigan. November 14, 2006.

Asbestos: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice committee of the Environmental Law Section of the State bar of Michigan.
Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on January 23, 2007. Presented at Varnum Riddering Schmidt Howlett LLP in Grand Rapids, Michigan on January 24, 2007.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 5, 2007.

Lead: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice committee of the Environmental Law Section of the State bar of Michigan.
Presented at the University of Detroit/Mercy Law School in Detroit, Michigan on March 12, 2007. Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on March 14, 2007. Presented at Varnum Riddering Schmidt Howlett LLP in Grand Rapids, Michigan on March 15, 2007. Presented at Wayne State University Law School in Detroit, Michigan on March 21, 2007.

Forensic Case Studies
Michigan Safety Conference
Devos Place. Grand Rapids, Michigan. April 17, 2007

Case Studies in Forensic Medicine
Consulting Physicians P.C. Spring 2006 Medical Education Seminar
Holiday Inn South Convention Center. Lansing, Michigan April 18, 2006.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 7, 2007.

Chromium: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State bar of Michigan.
Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on July 23, 2007.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 9, 2007.

Legal Considerations for Physicians when Patients Sign Out of Hospital Against Medical Advice.
Presentation to the medical staff of Henry Ford Bi-County Hospital.
Henry Ford Bi-County Hospital. Warren, Michigan. August 14, 2007.

Law, Medicine, and Industrial Hygiene
Presentation at the Annual Scientific Meeting of the Michigan Occupational and Environmental Medicine Association
Michigan State University Kellogg Conference Center
East Lansing, Michigan. September 28, 2007

Industrial Hygienist as a Consultant
Moderator of the Mini-conference
Michigan Industrial Hygiene Society
Michigan State University Management Education Center
Troy, Michigan. October 9, 2007

Respiratory Physiology
Department of Biomedical Engineering
Wayne State University
Detroit, Michigan November 7, 2007

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. November 12, 2007

Vapor Intrusions: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State bar of Michigan.
Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on November 20, 2007. Presented at Varnum Riddering Schmidt Howlett LLP in Grand Rapids, Michigan on November 16, 2007.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 11, 2008

Vapor Intrusion: Law Medicine and Science. Present to the Illinois State Bar Association Environmental Law Section. Chicago, Illinois. February 29, 2008

Basics of Toxic Tort Law
Ave Maria Law School
Ann Arbor, Michigan March 12, 2008

Toxic Tort Law
Chicago Bar Association
Continuing Legal Education Series
Chicago, Illinois March 19, 2008 March 19, 2008

Forensic Medicine, Engineering, and Industrial Hygiene
Industrial Hygiene Section
Michigan Safety Conference
Lansing Convention Center
Lansing, Michigan April 15, 2008

Complex Disability Determinations
Michigan Occupational Health Nurses Section
Michigan Safety Conference
Lansing Convention Center
Lansing, Michigan April 15, 2008

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 19, 2008

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 11, 2008

Toxic Tort: What's Living in Your Sand Castle
Accident Fund 6th Annual TPA Conference
M.S.U. Henry Center
Lansing, Michigan. September 25, 2008

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. November 3, 2008

Respiratory Physiology
Department of Biomedical Engineering
Wayne State University
Detroit, Michigan November 10, 2008

Vapor Off-gassing: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan.
Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on February 18, 2009.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 4, 2009

Employment Contracts for Cardiologists. Presented to the interventional cardiology fellows at St. John Hospital and Medical Center. Detroit, Michigan. June 1, 2009.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 3, 2009

Mold: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan.
Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on March 30, 2010.

Forensic Toxicology
Presentation to the Midwest Association for Toxicology and Therapeutic Drug Monitoring 2010 Annual Meeting
Crowne Plaza Hotel, Milwaukee Wisconsin. April 30, 2010

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 10, 2010

Interesting Forensic Cases
Greater Peoria Claims Association
Edwards, Illinois. May 13, 2010

Vapor Intrusions: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan.
Presented at and the Chicago office of Barnes & Thornburg LLP and telecasted to their various offices on June 11, 2010.

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 25, 2010

Bioterrorism
Wayne State University
Department of Occupational and Environmental Health
Detroit, Michigan September 29, 2010

Toxicogenomics in Toxic Tort litigation
Environmental Law Section
State Bar of Michigan
Annual Meeting
Devos Place
Grand Rapids, Michigan September 30, 2010

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 7, 2011

Oil Spills: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan.
Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on February 1, 2011.

Legal Aspects of Industrial Hygiene
American Industrial Hygiene Association – Chicago Section
Holiday Inn- Willow Brook, Illinois
March 16, 2011

Interesting Occupational and Environmental Forensic Cases
Loyola University Medical School
Department of Epidemiology and Preventive Medicine
Chicago, Illinois
March 18, 2011

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 9, 2011

Occupational Medicine Case Studies
Wayne State University
Department of Occupational and Environmental Health
Detroit, Michigan June 27, 2010

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. August 8, 2011

Panel Discussion: Environmental Law in Michigan after Trentadue.
Environmental Law Section
State Bar of Michigan Annual Meeting
Dearborn, Michigan. September 15, 2011

Low Speed Automobile Collisions.
Metro Detroit Office of Ernest Chiodo P.C.
Clinton Township, Michigan. November 3, 2011

Low Speed Automobile Collisions.
Royal Society of Medicine
London, UK. November 28, 2011

Low Speed Automobile Collisions.
City Place
West Palm Beach, Florida. January 14, 2012

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. February 27, 2012

Lead: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan.
Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on March 6, 2012.

Interesting Forensic Cases
Saginaw Valley Adjuster Association
Frankenmuth, Michigan March 13, 2012

Low Speed Automobile Collisions
Arizona Insurance Claim Association
Phoenix, Arizona March 15, 2012

Worker's Compensation for Occupational Medicine Physicians
and Law and Medicine for the Occupational Medicine Physician
Department of Family Practice
Division of Occupational Medicine
Wayne State University School of Medicine
Detroit Michigan. May 7, 2012

Interesting Forensic Cases
Midwest Claim Conference
Grand Geneva Resort and Spa
Lake Geneva, Wisconsin May 17, 2012

Mold: Law, Medicine and Science
Presentation of the Environmental Litigation and Administrative Practice Committee of the Environmental Law Section of the State Bar of Michigan.
Presented at Ernest Chiodo P.C. in Clinton Township, Michigan on May 21, 2012.

Determining Injury Causation in Motor Vehicle Collisions
Auto-Owner's Nurse Case Managers and Adjuster
Auto-Owner's Headquarters
Lansing, Michigan. June 25, 2012

Interesting Forensic Cases
Grand Rapids Area Adjusters Association
Grand Rapids, Michigan
October 1, 2012

Interesting Forensic Cases.
The National Society of Professional Insurance Investigators-Illinois Chapter.
Downers grove, Illinois.
December 6, 2012

Introduction to Toxic Tort Law
Wayne State University Law School
Detroit, Michigan
February 11, 2013

Introduction to Toxic Tort Law
Environmental Law Club of Northern Illinois University Law School
DeKalb, Illinois
April 3, 2013

Forensic Industrial Hygiene
American Industrial Hygiene Association Indiana Section
Indianapolis, Indiana
April 10, 2013

Evaluating Injury Causation in Low Speed Automobile Accidents
Michigan Adjusters Association Seminar 113
Zender's of Frankenmuth
Frankenmuth, Michigan
May 3, 2013

Evaluating Injury Causation in Low Speed Automobile Accidents
AAA of Michigan
Southfield, Michigan
May 22, 2013

Biotechnology
The Strategy Symposium
University of Chicago Booth School of Business
Chicago, Illinois
April 25th and 26th, 2014

Forensic Industrial Hygiene
University of Michigan School of Public Health
Ann Arbor, Michigan
October 2, 2015

Forensic Medicine
St. John Providence Macomb-Oakland Hospital
Madison Heights, Michigan
October 8, 2015

Wayne State University Law School Alumni Speaker Series - Law in Health Industry
Damon J. Keith Center for Civil Rights
Wayne State University Law School
Detroit, Michigan
November 19, 2015

Clean Water Standards: Keeping Government Accountable for Public Health
Illinois Campaign for Political Reform
Chicago, Illinois
July 27, 2016

The Emperor Has No Cloths: Injury Causation and Determination
Juris Educational Resource Knowledge for Legal Nurse Consulting
8th Annual Medical-Legal Nurse Conference
Raleigh, North Carolina
October 6, 2017

Forensic Industrial Hygiene
University of Michigan School of Public Health
Ann Arbor, Michigan
December 1, 2017

Medical Experts in Injury Causation Analysis
Michigan Defense Trial Counsel Winter Meeting
Novi, Michigan
November 9, 2018

Forensic Industrial Hygiene
University of Michigan School of Public Health
Ann Arbor, Michigan
December 7, 2018

Epidemiology and Work Related Exposures
2021 Annual Convention of the Workers' Injury Law & Advocacy Group
The Breakers
Palm Beach, Florida
September 27, 2021

Determination of COVID Causation
Medical/Legal Committee of Oakland County Michigan Bar Association
November 3, 2022

London Healthcare Innovation Forum
More than a Trend: What Healthcare Needs to Become Fit for Future Society and Cultural Changes
Panel Speaker
Canary Warf
One Canada Square
London, UK
April 3, 2025

PUBLICATIONS:

Chiodo EP. Huff SH. Hadden DW. Increased Health, Life, and Disability Insurance Premium Costs: A New Class of Economic Damages in Toxic Tort Cases in Michigan. 17 Mich Env LJ, No 3. pp 3-6 (1999).

Hadden DW. Chiodo EP. Huff SH. The State of Trespass-Nuisance Law in Michigan. 18 Mich Env LJ. No 1. pp 8-11 (2000).

Chiodo EP. Genetic Evidence in Paternity Cases: What the Lawyer Must Know. Michigan Family Law Journal. Volume 30 Number 2. pp 11-12 (2001).

Chiodo Ernest P., Musial Joseph L, Robinson J Sia. An Error In Statistical Logic In The Application Of Genetic Paternity Testing. Journal OF Modern Applied Statistical Methods. Winter 2002. Volume 1, Number 1. pp 126-129.

Chiodo Ernest P., Huff Steven H. Attributable Risk Percent: A Unified Epidemiological Measure of Damages in Toxic Tort Cases. 21 Mich Env LJ. No 2. pp 12-14 (2004).

Chiodo Ernest P, Hadden Donnelly W, Huff Steven H. The State of Medical Monitoring Damages in Michigan after Henry v. Dow Chemical Co.26 Mich Env L J No 1, pp1-7 (2008).

Chiodo Ernest P. Economic and non-economic issues must be considered in toxic damage cases. Michigan Lawyers Weekly. June 1, 2009.

Toxicogenomics and Toxic Tort Litigation. 28 Mich Env L J No1 Pages 10-12. (2010).

Evaluating Injury Causation in Low Speed Automobile Collisions. November 7, 2011. Claims Journal.

Consider Medical Specialist Expertise Carefully in Crash Injury Cases. October 5, 2012. Claims Journal.

What to Know About Determining Medical Causation of Injury or Illness. Laches. Oakland County, Michigan Bar Association. September 2022. Number 651. Page 11-13.

To a Reasonable Degree of Medical Certainty. Bar Briefs. Official Publication of the Macomb County, Michigan Bar Association. Volume 42. Number 11. May 2024. Page 6.

BOOKS:

Ernest P. Chiodo, M.D., J.D., M.P.H. Toxic Tort: A Guide to Toxic Substances Litigation in Michigan. Xlibris. Copyright 2002. Library of Congress Number 2002095046. ISBN Hard cover 1-4010-7725-0 Soft cover 1-4010-7386-7.

Ernest P. Chiodo, M.D., J.D., M.P.H. Toxic Tort: Medical and Legal Elements. Xlibris. Copyright 2004. Library of Congress Number 2003092354. ISBN Hard cover 1-4134-0537-1 Soft cover 1-4134-0536-3.

Ernest P. Chiodo, M.D., J.D., M.P.H., C.I.H. Toxic Tort: Medical and Legal Elements. Second Edition. Xlibris. Copyright 2007. ISBN Hard cover 1-4257-4962-3. Soft cover 1-4257-4961-5.

Ernest P. Chiodo, M.D., J.D., M.P.H., M.S., M.B.A., C.I.H. Bioterrorism.
Xlibris. Copyright 2013. ISBN Hard cover 978-1-4797-8431-8. Soft cover 978-1-4797-8430-1. Ebook 978-1-4797-8432-5.

Ernest P. Chiodo, M.D., J.D., M.P.H., C.I.H. Toxic Tort: Medical and Legal Elements. Third Edition. Xlibris. Copyright 2013. ISBN Hard cover 978-1-4797-8434-9. Soft cover 978-1-4797-8433-2.

Ernest P. Chiodo, M.D., J.D., M.P.H., C.I.H. Carbon Monoxide: Medical and Legal Elements. Xlibris. Copyright 2015. ISBN Hard cover 978-1-4990-3061-7. Soft cover 978-1-4990-3060-0. eBook 978-1-4990-3062-4.

Ernest P. Chiodo, M.D., J.D., M.P.H., C.I.H. Mold: Medical and Legal Elements. Xlibris. Copyright 2015. ISBN Hard cover 978-1-5144-1765-2. Soft cover 978-1-5144-1764-5. eBook 978-1-5144-1763-8.

BOOK CHAPTERS:

Thomas W. Armstrong, Ernest P. Chiodo, Robert F. Herrick, and Christopher P. Rennix. Occupation Epidemiology. Chapter 6. The Occupational Environment: Its Evaluation, Control, and Management. 3rd edition. Copyright 2011 by the American Industrial Hygiene Association. ISBN 978-1-935082-15-6.

Crisis Management & Emergency Planning: Preparing for Today's Challenges
Chapter 13: Legal Considerations in Threat Response Management
Copyright 2014 by Taylor & Francis Group, LLC. ISBN 13:978-1-4665-5505-1.

Hospital Emergency Management: A Bible for Hospital Emergency Managers
Chapter 12: Legal Considerations for the Emergency Manager and Physician
Copyright 2017 Dr. Robert J. Muller, M.D. ISBN 13: 9781537683560

PROFESSIONAL HONORS:

Co-author of the first place winning presentation at the 54th annual Providence Hospital Clinic Day. This was the first time that the Department of medicine had won the first place award in 19 years.

1991 Oakland Health Education Program Award for Research

Honored by the Wayne State University College of Engineering Hall of Fame in 2019 as a Distinguished Biomedical Engineer

I have received the rare honor of the Distinguished Alumnus Award for 2023 from Wayne State University School of Medicine. Wayne State University started in 1868 as a medical school. Wayne State University School of Medicine is the largest single campus medical school in the United States of America. Tens of thousands of physicians and surgeons have graduated from Wayne State University School of Medicine since 1868. I am only the 135th graduate of Wayne State University School of Medicine to receive the Distinguished Alumnus Award.

FOREIGN LANGUAGE PROFICIENCY:

German - Strong conversational proficiency
Mandarin Chinese - moderate conversational proficiency
Italian - minor to moderate conversational proficiency
Arabic - minor conversational proficiency

EXHIBIT 7

Ernest P. Chiodo, M.D., J.D., M.P.H., M.S., M.B.A., C.I.H.
35770 Harper Avenue
Clinton Township, Michigan 48035
Tel. (586) 746-1761

July 28, 2025

Jennifer L. Beidel, Esq.
jbeidel@dykema.com
248-203-0506
Alison A. Furtaw, Esq.
afurtaw@dykema.com
248-203-0592
Dykema

Re: United States of America v. Hoau-Yan Wang
In the United States District Court for the District of Maryland
Case No.: 8:24-cr-00211

Dear Ms. Beidel and Ms. Furtaw;

You have asked me to provide an opinion in this matter. I have in this report cited from the Reference Manual on Scientific Evidence (3rd Edition) (the "Reference Manual"). This is in order to provide an independent reliable authority to assist in the assessment of my opinion in light of possible opposing expert opinion in this matter.

THE REFERENCE MANUAL

The Reference Manual is a joint publication of the Federal Judicial Center and the National Research Council. The Federal Judicial Center serves as the educational and research agency for the federal judiciary and is chaired by Chief Justice Roberts of the United States Supreme Court. The National Research Council is the working arm of the United States National Academies, which include the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. As stated in the preface, the purpose of the Reference Manual is to assist judges in managing cases involving complex and scientific and technical evidence by providing authoritative guidance on the principles and methods underlying various scientific disciplines.

> **The Reference Manual . . . is formulated to provide the tools for judges to manage cases involving complex scientific and technical evidence. It describes basic principles of major scientific fields from which legal evidence is typically derived and provides examples of cases in which such evidence was used. Authors of the chapters were asked to provide an overview of principles and methods of the science and provide relevant**

> **citations . . . . This edition of the manual has also gone through the thorough review process of the National Academy of Sciences.**

The Reference Manual is available free online in PDF format.

My qualifications to render an opinion in this matter are as follows:

QUALIFICATIONS TO OPINE

My qualifications include a Bachelor of Arts (B.A.) in Health Science from Kalamazoo College, a Medical Degree (M.D.) from Wayne State University School of Medicine, a Juris Doctor (J.D.) from Wayne State University Law School, a Master of Public Health (M.P.H.) from Harvard University School of Public Health, a Master of Science (M.S.) in Biomedical Engineering from Wayne State University, a Master of Science (M.S.) in Threat Response Management (biological, chemical, and radiological defense) from the University of Chicago, a Master of Science (M.S.) in Occupational and Environmental Health Sciences with Specialization in Industrial Toxicology from Wayne State University, a Master of Business Administration (M.B.A.) with a concentration in economics from the University of Chicago, a Master of Science (M.S.) in Evidence Based Health Care (evidence based medicine) from the University of Oxford in the UK, a Master of Science (M.S.) in Experimental and Translational Therapeutics (drug, vaccine, and medical device development) from the University of Oxford, and a Master of Science (M.S.) in Nanotechnology for Medicine and Health Care from the University of Oxford.

I am board certified in the medical specialties of Internal Medicine, Occupational Medicine, and Public Health and General Preventive Medicine. Internal Medicine is the medical specialty focused upon the diagnosis and treatment of diseases in adults including neurological diseases such as Alzheimer's Disease. Public Health and General Preventive Medicine is the medical specialty most focused upon epidemiology and biostatistics. Epidemiology is the discipline involved in the assessment of factors that may improve or harm health. Occupational Medicine is the specialty most focused upon the diagnosis, treatment and prevention of work and environmentally caused diseases. I am also certified in the engineering and public health discipline of industrial hygiene by the American Board of Industrial Hygiene as a Certified Industrial Hygienist (C.I.H.) in the comprehensive practice of industrial hygiene.

I served for many years as an assistant clinical professor of internal medicine, family medicine, and public health at Wayne State University School of Medicine. I have also served as an adjunct assistant professor of industrial hygiene and toxicology at Wayne State University.

I have served as the Medical Director and Manager of Medical and Public Health Services for the City of Detroit and was the chief physician responsible for measures designed to protect the public health of over one million persons living or working in the City of Detroit at the time of my service. This was a position of substantial public responsibility where I had the direct telephone number to the United States White House

in the event that I needed to contact the President (Bill Clinton) due to a public health emergency in Detroit needing the immediate attention of the President.

I have also been elected to full membership in the Society of Toxicology.

I have been honored by the Engineering Hall of Fame of Wayne State University College of Engineering as a Distinguished Biomedical Engineer.

I have received the rare honor of the Distinguished Alumnus Award for 2023 from Wayne State University School of Medicine. Wayne State University started in 1868 as a medical school. Wayne State University School of Medicine is the largest single campus medical school in the United States of America. Tens of thousands of physicians and surgeons have graduated from Wayne State University School of Medicine since 1868. I am only the 135th graduate of Wayne State University School of Medicine to receive the Distinguished Alumnus Award.

OPINION

I have reviewed Reports 4.1 through 4.18 authored by Paul S. Brookes, Ph.D. ("Dr. Brookes"). In these reports, Dr. Brookes purports to have conducted image analyses that form the basis for his opinion that Hoau-Yan Wang ("Dr. Wang") falsified Western blots included in a Federal grant application submitted to the National Institute of Health ("NIH").

In his reports, Dr. Brookes does not cite any peer-reviewed medical literature to support the assertion that he employed a recognized or validated methodology in forming his opinion that certain Western blots were falsified by Dr. Wang. To my knowledge, Dr. Brookes did not examine the original Western blot films generated by Dr. Wang; rather, it is my understanding that his analysis was limited to reviewing images purported to depict the original Western blots.

Western blotting is a laboratory technique used to detect specific proteins in a mixture by separating them via electrophoresis, transferring them to a membrane, and probing with antibodies specific to the target protein.

To assess whether Dr. Brookes employed a scientifically recognized methodology in support of his opinion that Dr. Wang falsified certain Western blot images submitted in connection with federal NIH grant applications, I conducted a comprehensive review of the peer reviewed literature. This search was performed using the database of the United States National Library of Medicine, the largest and most authoritative repository of peer-reviewed medical journal articles in the world, containing more than 37 million indexed citations dating back to the 19th century.

I conducted this search using the same systematic methodology I was trained to use as part of the Master of Science program in Evidence-Based Health Care at the University of Oxford, which is internationally recognized as a leading institution in the discipline of evidence-based medicine.

Based on this search and analysis, it is my professional opinion that there is no support in the peer-reviewed medical or scientific literature for the proposition that Dr. Brookes utilized a recognized or validated scientific methodology in arriving at his conclusion that Dr Wang falsified the Western blot images submitted for the NIH Federal grant application.

Should Dr. Brookes identify any peer-reviewed medical or scientific literature that he believes corroborates his methodology or conclusions, I would be glad to review and assess such materials.

I have also conducted a targeted search to determine whether the NIH imposes any specific requirements regarding the submission, formatting or presentation of Western blot images in NIH grant applications. Based on that search, there appear to be no NIH guidelines or federal regulations that prescribe a particular format for Western blot image submission or dictate how such images must be presented in grant materials. In the absence of such requirements, there is no legitimate basis for Dr. Brookes to offer any opinion that Dr. Wang falsified Western blot images in any NIH grant application. Any such opinion would be speculative and unsupported by applicable NIH standards or federal guidance.

In this matter, the relevant issue is whether any characteristics of the Western blot images reviewed by Dr. Brookes provide reliable evidence that the images were intentionally falsified beyond any reasonable doubt. Dr. Brookes may identify visual features in the images—purportedly derived from original Western blots—that, in his opinion, suggest falsification. However, if Dr. Brookes intends to offer an opinion that such features are indicative of intentional falsification, it is essential that he has conducted an appropriate evaluation of alternative explanations for those features, such as imaging artifacts resulting from imaging/scanning duplication, digital transfer anomalies, or permissible forms of image enhancement.

The recognized methodology in medical and scientific disciplines for determining the *Specific Cause* of an observed outcome is a differential diagnosis of etiology. As explained in the Reference Manual on Scientific Evidence (3rd Edition) ("Reference Manual") at page 690, a differential diagnosis is described as follows:

> **Differential diagnosis, for example, is an accepted method that a medical expert may employ to offer expert opinion that satisfies *Daubert*. In the legal context, differential diagnosis refers to a technique "in which physician first rules in all scientifically plausible causes of plaintiff's injury, then rules out least plausible causes of injury until the most likely cause remains, thereby reaching conclusion as to whether defendant's product caused injury."**

While the above passage refers to determining the cause of a disease in an individual patient, the underlying methodology—ruling in plausible causes and systematically ruling out alternatives—applies equally in the context of determining whether visual features of Western blot images are the result of intentional falsification. To reliably conclude that

any aspect of a Western blot image constitutes deliberate manipulation rather than an artifact or benign alteration, a scientific expert must engage in this recognized process or differential diagnosis. Without applying such a methodology, any assertion, such as those made by Dr. Brookes, that the images reflect intentional falsification lacks the methodological rigor required to meet established standards for scientific reliability in both the scientific and legal contexts.

The Reference Manual at page 613 further emphasizes the importance of differential diagnosis in the context of determining specific causation:

> **The process of differential diagnosis is undoubtedly important to the question of "specific causation". If other possible causes of an injury cannot be ruled out, or at least the probability of their contribution to causation minimized, then the "more likely than not" threshold for proving causation may not be met. But, it is important to recognize that a fundamental assumption underlying this method is that the final, suspected "cause" remaining after this process of elimination must actually be capable of causing the injury. That is, the expert must "rule in" the suspected cause as well as "rule out" other possible causes. And, of course, expert opinion on this issue of "general causation' must be derived from a scientifically valid methodology.**

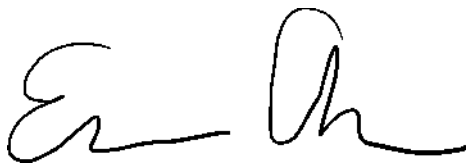
Dr. Brookes did not utilize any recognized methodology whereby he considered and systematically excluded alternative explanations for the visual characteristics of the Western blot images. Instead, his opinion that Dr. Wang falsified Western blot images rests solely on his subjective interpretation of supposed image irregularities, unsupported by any citation to peer-reviewed medical or scientific literature.

Moreover, Dr. Brookes' analysis does not include any application of a scientifically accepted method of differential diagnosis to establish "specific causation." In the absence of such a methodology, his opinion amounts to mere ipse dixit—conclusory assertions lacking foundational reliability under *Daubert*.

My complete list of testimony over the past four years and my current curriculum vitae are attached for the Court's reference.

My compensation is this matter is $600 per hour for all services other than testimony time. Testimony time (deposition or trial) is at the rate of $1,200 per hour with a three-hour minimum.

Very truly yours,



Ernest P. Chiodo, M.D., J.D., M.P.H., M.S., M.B.A., C.I.H.

EXHIBIT 8

Ernest P. Chiodo, M.D., J.D., M.P.H., M.S., M.B.A., C.I.H.
35770 Harper Avenue
Clinton Township, Michigan 48035
Tel. (586) 746-1761

September 5, 2025

Jennifer L. Beidel, Esq.
jbeidel@dykema.com
248-203-0506
Alison A. Furtaw, Esq.
afurtaw@dykema.com
248-203-0592
Emma K.F. Blackwood, Esq.
EBlackwood@dykema.com
(517) 703-6311
Dykema

Re: United States of America v. Hoau-Yan Wang
In the United States District Court for the District of Maryland
Case No.: 8:24-cr-00211

Dear Ms. Beidel, Ms. Furtaw, and Ms. Blackwood;

You have asked me to review the following additional materials in this matter:

1. Brookes Report 1-3.

2. Defendant's Motion in Limine to Exclude Expert Testimony of Paul Brookes, PhD.

3. Motion to Exclude Defendant Hoau-Yan Wang's Proposed Expert Testimony.

My opinion in this matter remains unchanged after the review of the above materials in this matter. However, in addition to the review of the above materials, I have also reviewed the following materials since I issued my initial report:

- Literature review NOT-OD-16-011 and Western Blot requirements for Federal grants. Review of 12-15-04 Preclinical Research Agreement.

- Review of Preclinical Research Agreement Amendment 12.1.07 to Preclinical Research Agreement 12.15.04.

- Review of Preclinical Research Agreement Amendment 9.15.08 to Preclinical Research Agreement 12.15.04.
- Review of Preclinical Research Agreement Amendment 3.15.09 to Preclinical Research Agreement 12.15.04.
- Review of Preclinical Research Agreement Amendment 5.1.09 to Preclinical Research Agreement 12.15.04.
- Review of Preclinical Research Agreement Amendment 2.15.11 to Preclinical Research Agreement 12.15.04.
- Review of Preclinical Research Agreement Amendment 4 11.29.17 to Preclinical Research Agreement 12.15.04.
- Review of Preclinical Research Agreement Amendment 5 3.8.19 to Preclinical Research Agreement 12.15.04.
- Review of Preclinical Research Agreement 8.01.12.
- Review of Preclinical Research Agreement Amendment 8.1.13 to Preclinical Research Agreement 08.01.12.
- Review of Preclinical Research Agreement Amendment 1.20.14 to Preclinical Research Agreement 08.01.12.
- Review of Preclinical Research Agreement Amendment 1.1.15 to Preclinical Research Agreement 08.01.12.
- Review of Preclinical Research Agreement Amendment 6.10.16 to Preclinical Research Agreement 08.01.12.
- Review of Clinical Trial Agreement 1.15.19.

In addition to the qualifications that I have previously listed, I have served as an adjunct professor of law at John Marshall Law School of Chicago and Loyola University Chicago School of Law. In addition, during my service as Medical Director and Manager of Medical and Public Health Services for the City of Detroit I was in charge of review of contracts between the City of Detroit Health Department and grant funders, including the Federal government of the United States. The Detroit Health Department had contracts with the Federal Government of the United States for grants in the amounts of tens of millions of dollars. Consequently, I am qualified to opine concerning whether or not the work of Dr. Wang was in compliance with the standards set forth in contracts in this matter.

It is my opinion after the review of the above agreements that the work of Dr. Wang was in compliance with the standards set forth in the agreements. I see no basis for any assertion that the work of Dr. Wang including but not limited to any Western Blot images was in breach of any agreed upon standards with the Federal government of the United States or otherwise. In specific, there was no indication in the agreements with the Federal government of the United States that Dr. Wang would conduct or present any Western Blot studies in any particular manner. There was certainly no agreement that Dr. Wang would conduct his work and present his Western Blot work in a manner consistent with the individual preferences of Paul Brookes PhD.

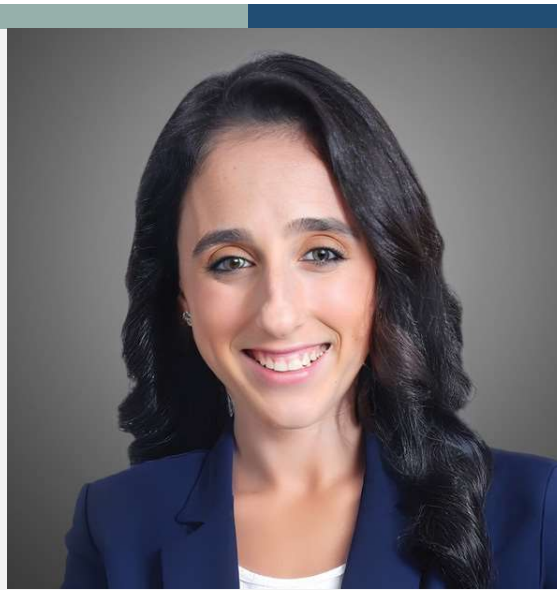
I have reviewed the Motion to Exclude Defendant Hoau-Yan Wang's Proposed Expert Testimony. The motion falsely claims that I have no knowledge or expertise concerning Western Blot technology and images. The assertion that the author of the motion claims is incorrect. A Western Blot is essentially the application of electrophoresis to proteins. I conducted my first electrophoresis at Wayne State University School of Medicine in 1978 when Paul Brookes was a young child. I have had formal course work in Western Blot technology while being a student at Wayne State University as well as at the University of Oxford. I have also utilized electrophoretic images including Western Blots during my long clinical practice as well as during my service as an Assistant Professor of Internal Medicine, Public Health, and Family Medicine at Wayne State University School of Medicine. From this and other of my knowledge, education and experience, I have sufficient expertise to provide my proposed opinions in this matter.

It is my opinion that the sole basis of the charge against Dr. Wang is the personal opinion by Paul Brookes PhD that he would have presented the Western Blot images in a manner other than how Dr. Wang presented the images. I simply do not see any basis for the assertion that Dr. Wang committed any intentional act of manipulation of those images in violation of any applicable standard.

Very truly yours,

Ernest P. Chiodo, M.D., J.D., M.P.H., M.S., M.B.A., C.I.H.

EXHIBIT 9



Alyssa Lisiewski

Managing Director

2000 K Street NW, 12th Floor | Washington, DC 20006

Contact

Mobile +1.301.356.7637
alyssa.lisiewski@ankura.com

Education

BA, Criminology and Criminal Justice, University of Maryland

MFS, High Technology Crime Investigations, The George Washington University

Certifications

Certified Forensics Analyst

Advanced Smartphone Forensics

Amazon Web Services Certified Cloud Practitioner

EnCase Certified Examiner

AccessData Certified Examiner

Department of Defense Digital Forensics Examiner

Department of Defense Certified Digital Media Collector

Affiliations

Global Information Assurance Certification (GIAC)

SANS

Exterro Forensics

Women in Cybersecurity (WiCyS)

March of Dimes

eCornell Women in Leadership

Alyssa Lisiewski is a Managing Director at Ankura based in Washington, DC. She has over 15 years of experience focusing in cybersecurity, insider threat investigations and digital forensics. She specializes in leading and conducting complex cyber investigations pivotal to safeguarding digital assets.

Alyssa's experiences includes operating in a digital forensic lab environment including the adherence to industry standards and reliable methods for safeguarding digital evidence, gathering data, and analyzing electronically stored information. Additionally, she has extensive experience in support of criminal investigations, intelligence investigations, and customer product development. She has been qualified as an expert, and testified, in the field of digital forensics within federal and military courts.

Before joining Ankura, Alyssa was the Cyber Forensic Program and Team lead at Capital One responsible for conducting high priority cyber forensics and cyber threat investigations. Prior to Capital One, she was a government contractor for the Department of Defense Cyber Crime Center leading complex digital forensics investigations in support of criminal investigations, was Chair of the DoD Cyber Forensics Lab Forensic Advisory Committee.. Prior to DoD, Alyssa was a government contractor for multiple federal agencies in the Intelligence Community providing digital/cyber forensics, investigations, and cyber security expertise.

Alyssa brings a unique background of expertise in criminology, cyber security, threat intelligence, dark web analysis, digital forensics, and insider threat. This diverse background allows her to approach complex challenges with a different mindset resulting in identifying and remediating cyber threats.

Relevant Experience

- **Cyber / Digital Forensics Expert witness services** - Processed, examined, and analyzed computers, mobile devices, gaming consoles, dark web, OSINT and other digital evidence in 80+ cases as a government contractor. Expert witness reports were produced for all cases with multiple verbal and written affidavits as an expert including three (3) instances of testifying in court as an expert witness. Alyssa also conducts forensic analysis and provides guidance in support of civil litigation, including expert witness testimony.

- **Cyber Threat Intelligence Investigations –** Led, conducted, and participated in over 25 cyber threat investigations for various government clients in the intelligence community. Alyssa led high multiple priority complex investigations combining cyber threat intelligence, cyber digital forensics, incident response/malware analysis, and insider threat analysis in a previous role.

- **Digital Forensics Investigations** – Led and conducted over 100 complex digital forensics investigations including preserving/acquiring physical and remote evidence, live RAM/Memory analysis, post-mortem forensic analysis, mobile device analysis (iOS and Android) using industry tools such as X-Ways, Cellebrite, EnCase, Axiom and FTK. Alyssa has also written, technical reviewed, and quality assurance reviewed expert witness forensic reports to attest for forensic acquisitions and analysis undertaken to support investigations in U.S federal and military court cases. Mentored junior digital forensic examiners in digital forensic best practices, complex analysis, and expert report writing.

Certifications and Awards

- eCornell Women in Leadership Program (Estimated Completion Date July 15 2025)
- Crucial Conversations for Mastering Dialogue – October 2024
- AWS Certified Cloud Practitioner - November 2021 (Renewed October 2024)
- GIAC Certified Forensic Analyst (GCFA) - July 2020 (Renewed January 2024)
- SANS FOR518 Mac and iOS Forensics and Incident Response Challenge Coin - June 2019
- CACI Performance Bonus - August 2018
- GIAC Advanced Smartphone Forensics (GASF) - July 2018 (Renewed July 2022)
- SANS FOR585 Advanced Smartphone Forensics Challenge Coin - April 2018
- CACI Performance Bonus March 2018
- DCFL Computer Forensic Examiner Major Crimes - February 2018
- CACI Performance Bonus - September 2017
- CACI Performance Bonus - June 2017
- DoD Digital Forensic Examiner - November 2016
- DCFL Computer Forensic Examiner Imaging & Extraction - October 2016
- DoD Digital Media Collector - October 2016
- EnCase Certified Examiner (EnCE) (EnCase V7) November 2014 (Most Recent Renewal December 2024)
- AccessData Certified Examiner (ACE) - October 2013 (renewed November 2015)
- Booz Allen Hamilton Performance and Team Award - June 2012
- Marvin C. Beasley, CPP Memorial Scholarship Recipient - March 2012
- Booz Allen Hamilton Performance and Team Award - August 2011
- CompTIA Security + Certification - December 2010

Professional Training/Conferences

- SANS Cyber Threat Intelligence Summit (Virtual) – January 2025
- Crucial Conversations for Mastering Dialogue – October 2024
- SANS Cloud Security Exchange 2024 – August 2024
- Exterro FTK Core (24 Hours) – May 2024
- WiCyS Virtual Summit – April 2024
- SANS Institute –Cloud Forensics (36 Hours) - November 2022
- SANS Institute -Advanced Incident Response, Threat Hunting, and Digital Forensics (36 Hours) - March 2020
- Autopsy Basics and Hands On (8 Hours) - March 2020
- SANS Institute – Mac and iOS Forensics and Incident Response (36 Hours) - June 2019
- SANS FIRE Conference 2019 – June 2019
- DC3/CFL Expert Witness Training (8 Hours) - February 2019
- SANS Institute - Advanced Smartphone Forensics (36 Hours) - April 2018
- SANS Conference 2018 – April 2018
- DC3/CITA - Abusing Windows StickyKeys (1 Hour) - January 2017
- DC3/CITA - Android Acquisition (1 Hour) - January 2017
- DC3/CITA - Network Intrusions Basics (10 Hours) - January 2017
- DC3/CITA - Windows Forensic Examinations EnCase (WFE-E) (80 Hours) – November 2016
- DC3/CITA - Computer Incident Responders Course Forensic Concepts (CIRC-FC) (40 Hours) – October 2016
- DC3/CITA - Introduction to Networks and Computer Hardware (INCH) (40 Hours) - October 2016
- Tresys Technology LLC - Fundamentals of SELinux Training (16 Hours) - June 2016
- The Volatility Foundation - Windows Malware and Memory Forensics (40 Hours) - April 2016
- AccessData Cloud Forensics (24 hours) - April 2015

Expert Testimony Experience

Trial/Bench

- US v. Michalec – General Court Marshall, Joint Base Charleston, South Carolina – May 2019
- US v. Michalec – General Court Marshall, Joint Base Charleston, South Carolina (Suppression Hearing) – February 2019
- US v. Sparks - US District Court, Hartford, Connecticut – June 2018

Declarations

- Bert Parrish, v. Vulcan Materials Company – June 2025

Other Litigation: Alyssa has provided multiple written affidavits for ongoing litigations that are not public at this time.

Publications

- Casey E, Nguyen L, Mates J, Lalliss S. Crowdsourcing forensics: Creating a curated catalog of digital forensic artifacts. J Forensic Sci. 2022 Sep;67(5):1846-1857. doi: 10.1111/1556-4029.15053. Epub 2022 Jul 11. PMID: 35816182; PMCID: PMC9543441. (Acknowledgment to Alyssa Lisiewski for contributions)

Presentations

- Cyber Careers Panel: Cyber Threat and Digital Forensics (Internal Capital One Cyber Presentation) - 2023
- Cyber Digital Forensics: What Do We Do? (Internal Women in Technology/Capital One Presentation) – 2023
- Insider Threat, Cyber Forensics, and eDiscovery Presentation (Capital One for CyberCoders) – 2022
- Cyber Digital Forensics: What Do We Do? (Internal Capital One Cyber Presentation) – 2022
  Insider Threat, Cyber Forensics, and eDiscovery Presentation Capital One for (Capital One for CyberCoders) – 2021

EXHIBIT 10

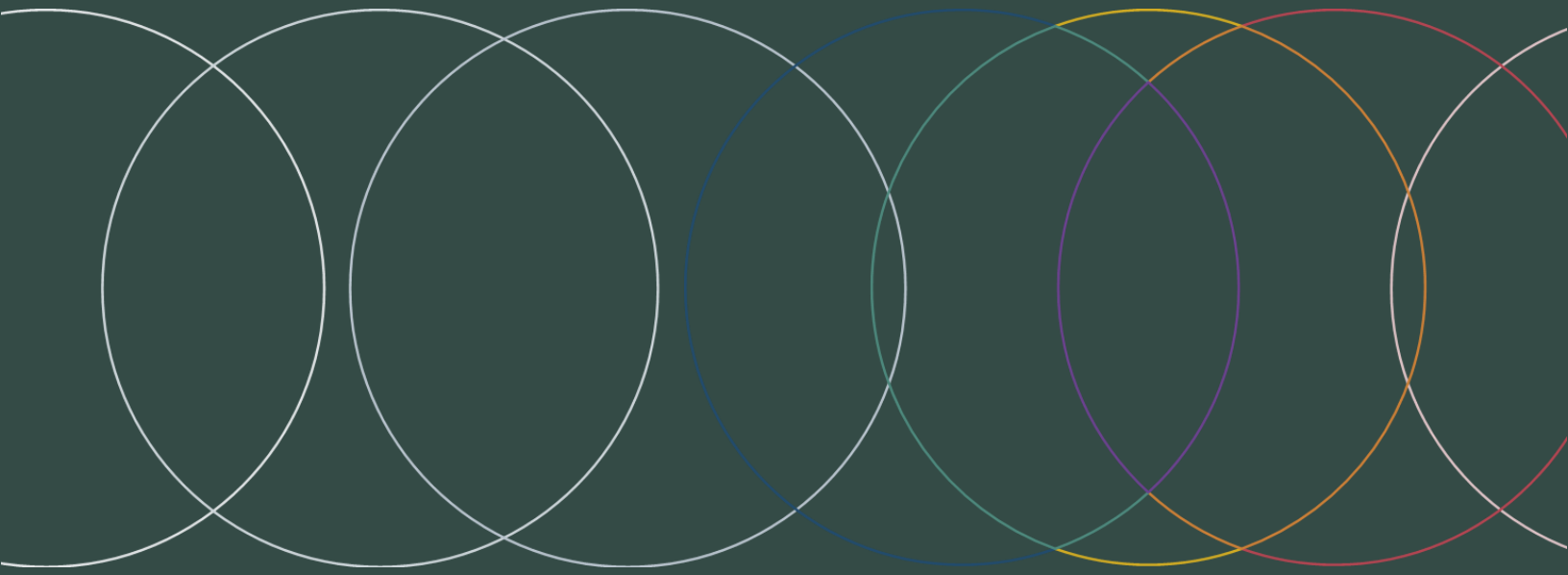
ankura

US v Wang
Forensic Expert Report

Prepared for: Dykema Gossett PLLC

Prepared by: Ankura Cyber Threat Investigations and Expert Services (CTIX) Team

July 2025



Confidential

TABLE OF CONTENTS

1 BACKGROUND AND SCOPE OF WORK

Dykema ("Counsel") engaged Ankura Consulting Group (Ankura) to perform a forensic metadata analysis of .jpg files with Photoshop metadata, PowerPoint files, and Grant applications as well as provide expert opinion on hash values.

Ankura reviewed Counsel provided documentation to include the "raw" and "white box" images noted in the report below as well as the intermediate PowerPoint, and the associated Grant.

Ankura's review focused specifically on forensic metadata analysis. In addition, Ankura interviewed Dr. Wang on July 23, 2025, to gain understanding of his general workflow to determine if images embedded within the intermediate PowerPoint, and the associated Grant could be identified by unique hash value.

A summary of findings is as follows:

1. Chronology re: Grant 5, Figure 3:
    a. Ankura was able to identify eight (8) files that appear to be part of the process associated with Figure 3.
2. Replication/testing of Dr. Wang's General process (from a hash analysis perspective):
    a. Ankura's digital forensic expert was able to replicate steps 3-6 of the process Dr. Wang described during the interview on July 23, 2025.
3. Hash Value Analysis:
    a. Ankura determined that the images embedded within the intermediate PowerPoint, and the associated Grant could not be identified by unique hash value.

2 METHODOLOGY

2.1 Chronology of Key Events Identified re: Grant 5, Figure 3

Ankura's digital forensic expert reviewed the chronology of events associated with Grant 5, Figure 3 regarding the documentation provided by Counsel. Ankura's forensic expert identified the "raw" and "white box" images noted in Section 3 below as well as the intermediate PowerPoint and the associated Grant. These files were reviewed in relation to Dr. Wang's general process that he described during the July 23, 2025 interview.

2.2 Replication/Testing of Dr. Wang's General Process

Ankura's digital forensic expert interviewed Dr. Wang on July 23, 2025, and understood his general process as below:

1. Scan the selected "Western Blot" films (result is a .tiff file)

2. Open .tiff file with tool ImageJ and save out as a JPEG/JPG
3. Open JPEG/JPG with Photoshop
    a. adjust contrast and brightness for the entire image
4. In Photoshop, frame and crop specific area
    a. save the selection as a JPEG/JPG
    b. paste the JPEG/JPG into PowerPoint
5. Once in PowerPoint, the individual rows are outlined, and each band is labeled to create the panel
6. Once the panel is completed in PowerPoint, it is saved in one of two ways:
    a. The PowerPoint slide is saved as a .tiff (this is done when the PowerPoint would be larger than 10MB since it needs to be emailed)
    b. The PowerPoint slide is saved as an image and pasted into a new slide and the original slide is deleted (this is done when the PowerPoint is under 10MB).

Steps 1 & 2 were not replicated or tested by the Ankura team as both steps are out of scope for forensic metadata analysis:

1. Scan the “Western Blot” films (result is a .tiff file)
2. Open .tiff file with tool ImageJ and save out as a JPEG/JPG

Ankura’s digital forensic expert was able to recreate steps 3-6. For purposes of testing the steps 3-6 of Dr. Wang’s general process, Ankura utilized the following JPG file: *butterfly.jpg*

butterfly.jpg

This file was downloaded by Ankura’s digital forensic expert and hashed prior to the testing of Dr. Wang’s general process.

The MD5 hash value for this file is:

C0ED5B763C552260B2B8BB0D419176CF

For steps 3 & 4, Ankura utilized Adobe Photoshop 2025 Version: 26.8.1.

IMPORTANT NOTE: Ankura adjusted the contrast and brightness for the entire image as Dr. Wang noted during the interview; however, Ankura does not have specifics regarding the contrast and brightness adjustments utilized in the "Western Blot" process. Ankura's adjustments to the contrast and brightness were selected to clearly show changes.

For steps 5 & 6, Ankura utilized Microsoft® PowerPoint® for Microsoft 365 MSO (Version 2506).

2.3 Forensic Hash Analysis Methodology

A hash value is a digital fingerprint unique to each file; if file content is changed then the hash value will change. The hash value is a fixed-size string of characters which is generated by a mathematical process and the output is a unique digital fingerprint.

Ankura's digital forensic expert utilized various industry standard forensic tools to obtain the hash value for the following files:

- *125p2a-plasma pS2152 -1.jpg*
- *125p2a-plasma-Alb-GAPDH-1.jpg*
- *125p2a-plasma-M58420H7-1.jpg*
- *125p2a-plasma pS2152-1-11.jpg*
- *125p2a-plasma-Alb-GAPDH-1-11.jpg*
- *125p2a-plasma-M58420H7-1-11.jpg*
- *125p2a-plasma- Alb-GAPDH-1-112.jpg*
- *Lymphocyte -90KDa-Origene-M58420H7-CASSAVA.pptx*

Ankura's digital forensic expert opened the PowerPoint file *Lymphocyte -90KDa-Origene-M58420H7-CASSAVA.pptx* and reviewed the contents. Ankura's digital forensic expert determined that the individual images had been merged into a chart before being embedded into PowerPoint, and as a result, they could not be saved separately as individual images from the presentation. Consequently, these images could not be exported or hashed for comparison.

This appears consistent with the steps that Dr. Wang described during the July 23, 2025, interview with Ankura.

Similarly, Ankura's digital forensic expert opened the PDF version of the Grant 5 file, titled *Grant 5 – 57329-03 [Proposal 2]* and reviewed the contents. Ankura's digital forensic expert found that the individual images within the document could not be extracted because they had also been merged prior to embedding. Therefore, they could not be exported or hashed for comparison. The Grant 5 file was also converted from a PDF to a Word document, but the individual images still could not be exported from the Word file.

3 FINDINGS

3.1 Chronology of Key Events Identified re: Grant 5, Figure 3 Findings

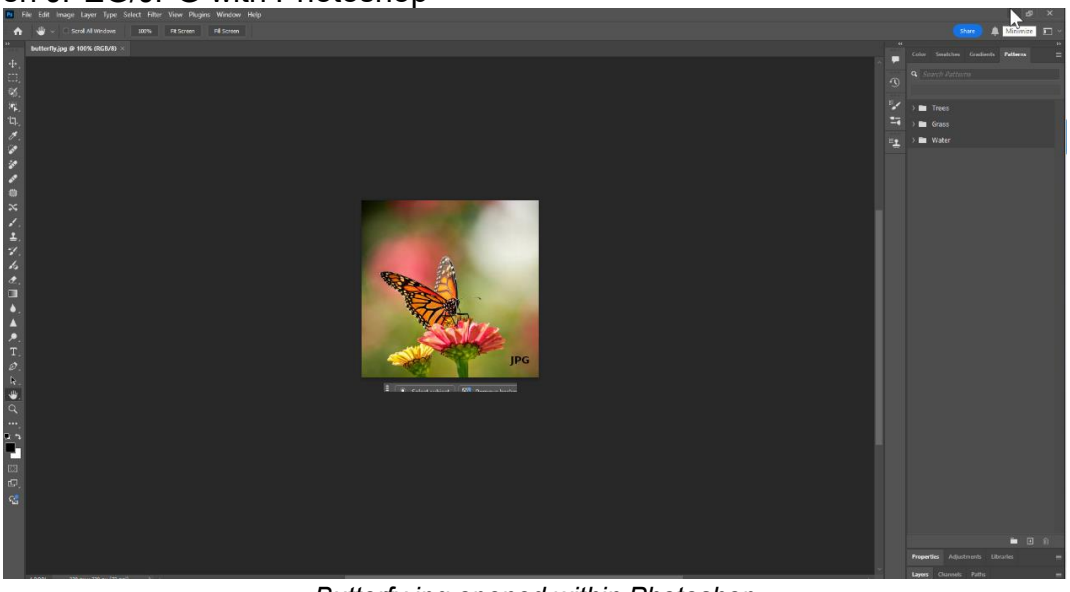
Ankura's review of the key events identified the following eight (8) files that appear to be part of the process associated with Grant 5, Figure 3:

- *125p2a-plasma pS2152-1.jpg*
- *125p2a-plasma-Alb-GAPDH-1.jpg*
- *125p2a-plasma-M58420H7-1.jpg*
- *125p2a-plasma pS2152-1-11.jpg*
- *125p2a-plasma-Alb-GAPDH-1-11.jpg*
- *125p2a-plasma-M58420H7-1-11.jpg*
- *125p2a-plasma- Alb-GAPDH-1-112.jpg*
- *Lymphocyte -90KDa-Origene-M58420H7-CASSAVA.pptx*

3.2 Replication/Testing of Dr. Wang's General Process Findings

As previously noted, Steps 1 & 2 were not replicated or tested by the Ankura team as both steps are out of scope for forensic metadata analysis associated with the images within the PowerPoint and Grant.

1. Scan the "Western Blot" films (result is a .tiff file) – Not tested; out of scope.
2. Open .tiff file with tool ImageJ and save out as a JPEG/JPG – Not tested; out of scope.
3. Open JPEG/JPG with Photoshop



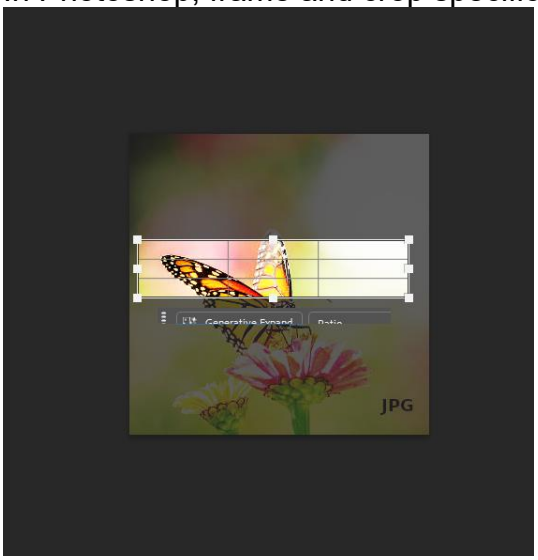
Butterfy.jpg opened within Photoshop

   a. adjust contrast and brightness for the entire image

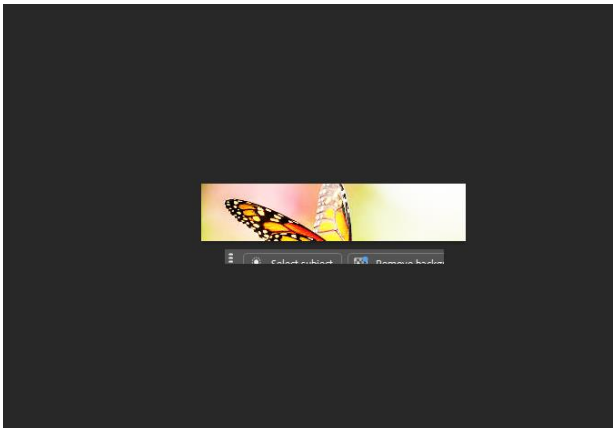
butterfly copy_brightness_contrast_adjusted.jpg

The MD5 hash value for this new file is: *1F5239FFA11EE3518EA8DFA5DE0C6461*

4. In Photoshop, frame and crop specific area



Screenshot showing selection

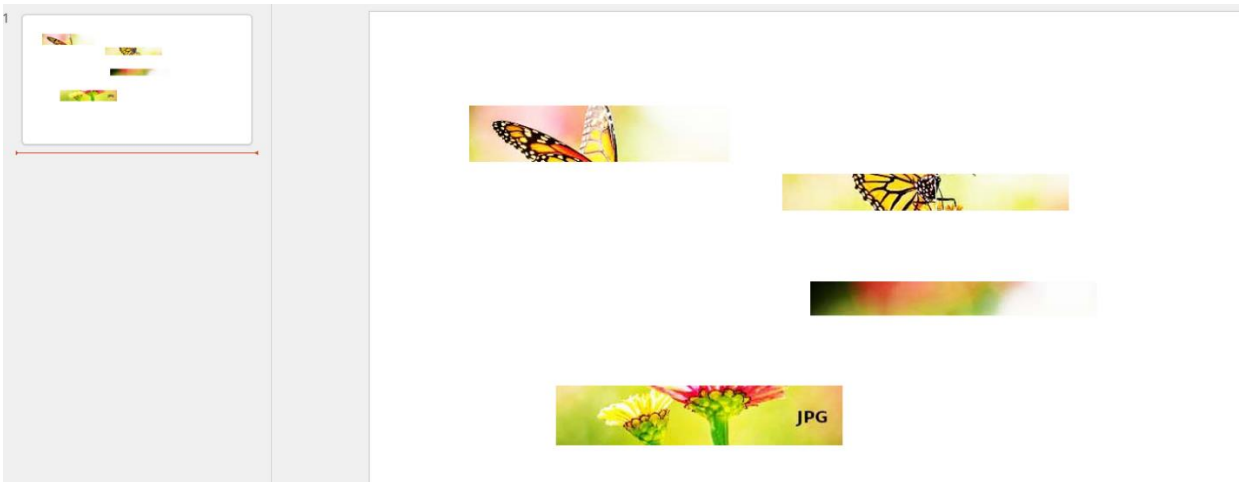


Screenshot showing cropped selection

a. save the selection as a JPEG/JPG

butterfly_crop.jpg

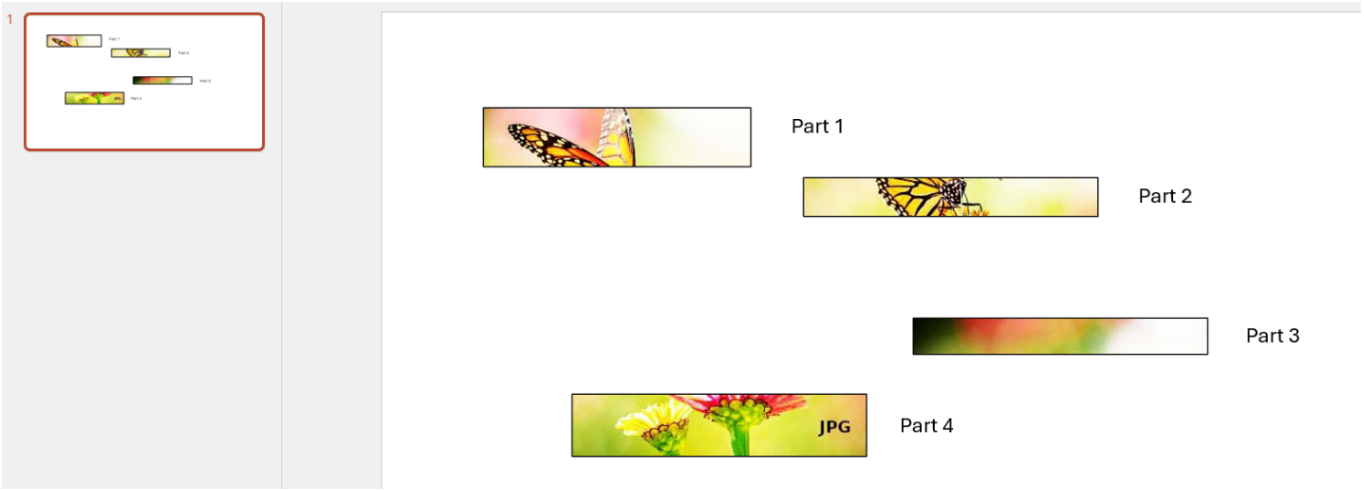
b. paste the JPEG/JPG into PowerPoint



PowerPoint slide with cropped selections pasted

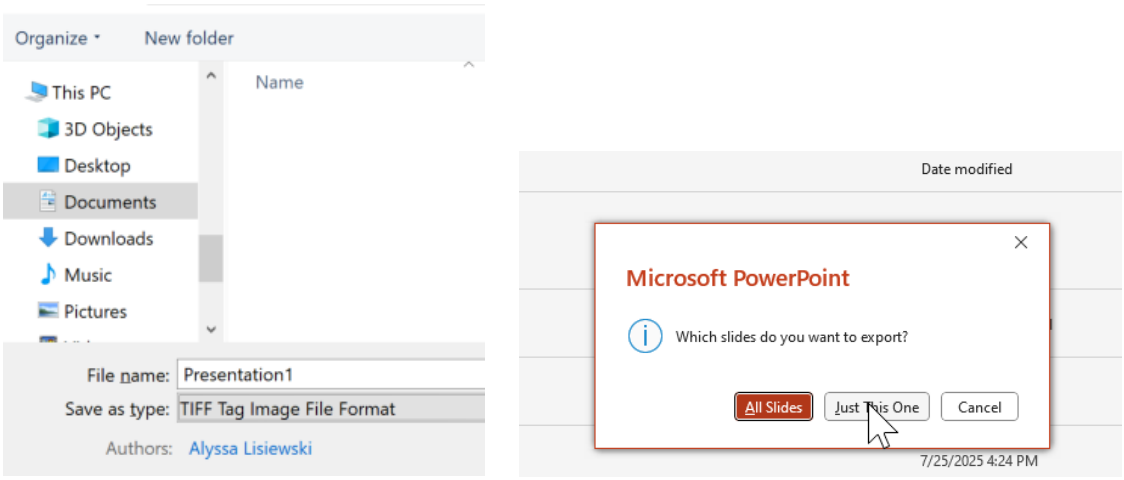
Ankura repeated step 4 three (3) additional times

5. Once in PowerPoint, the individual rows are outlined, and each band is labeled to create the panel

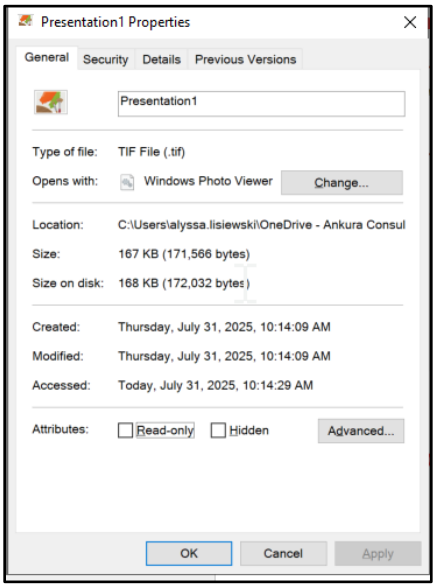


PowerPoint slide with outlines and labels

6. Once the panel is completed in PowerPoint, it is saved in one of two ways:
    a. The PowerPoint slide is saved as a .tiff (this is done when the PowerPoint would be larger than 10MB since it needs to be emailed)

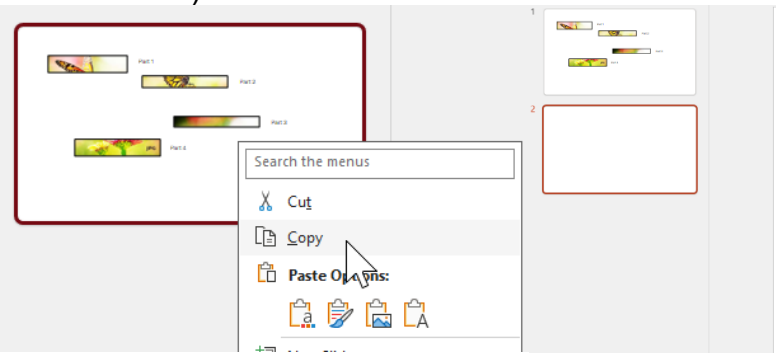


Saving PowerPoint slide as .tiff

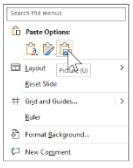


Details of PowerPoint slide saved as .tiff

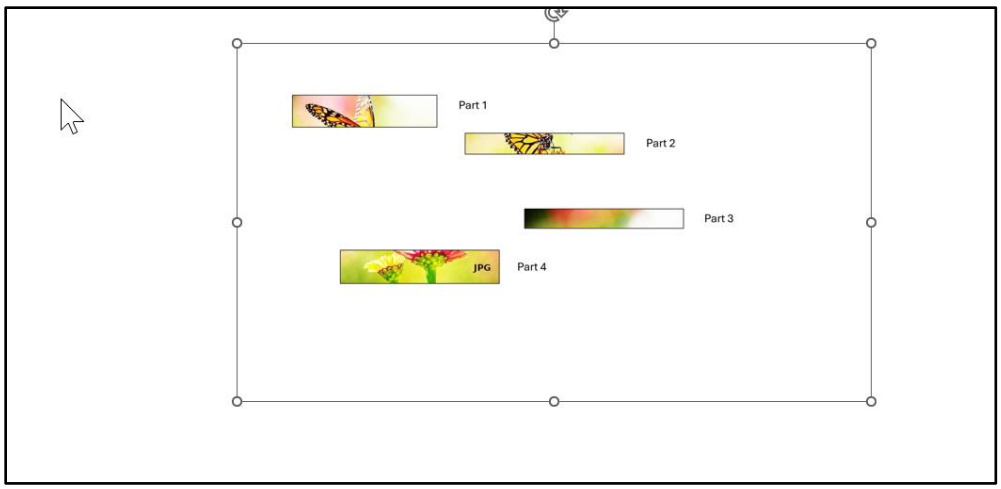
b. The PowerPoint slide is saved as an image and pasted into a new slide and the original slide is deleted (this is done when the PowerPoint is under 10MB).



Copying of PowerPoint slide



Paste as picture into new PowerPoint slide



Pasted picture into new PowerPoint slide

Ankura's digital forensic expert was able to replicate steps 3 – 6 of the general process Dr. Wang described during the interview on July 23, 2025. The process of cropping the images within Photoshop and pasting into PowerPoint, as well as saving the slide in both formats (as a .tiff and as a picture on its own slide), resulted in merged images that could no longer be hashed at an individual level for comparison.

3.3 Forensic Hash Analysis

The individual images were not present as separate entities within the PowerPoint file or within the Grant file. The merged content within these files could not be hashed at the individual row or "white box" level, and there was no available method to match the images based on hash value. At the time of Ankura's analysis, Ankura's digital forensic expert was not aware of any digital forensic process capable of identifying and isolating individual image components by hash value. Therefore, Ankura cannot confirm that these images are the same based on hash comparison.

MD5 hash values were noted for the following files that were identified during the review of the key events.

	Filename	**Hash MD5**
"raw" image 1	125p2a-plasma pS2152-1.jpg	b7b5d94ce9c0fe210d3aa661246a7df2
"White Box" image 1	125p2a-plasma pS2152-1-11.jpg	c75c12aa4de9dee554bf376121213287
"raw" image 2	125p2a-plasma-Alb-GAPDH-1.jpg	a3e0cfb4232d492abd474ac4592929c6
"White Box" image 2	125p2a-plasma-Alb-GAPDH-1-11.jpg	77ccdc9c2027c51046083526266df935

"White Box" image 4	125p2a-plasma-Alb-GAPDH-1-112.jpg	61755c070785b0b1ea9aa3dc8e0745ff
"raw" image 3	125p2a-plasma-M58420H7-1.jpg	63bbc9c894543d1c8237ffc0d3415a89
"White Box" image 3	125p2a-plasma-M58420H7-1-11.jpg	7634e383cbb6b4024e89a899addcfd7b
PowerPoint	Lymphocyte -90KDa-Origene-M58420H7-CASSAVA.pptx	7a528e52fae190f3a249106a90214111